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ABSTRACT

The report discusses research activities carried out to investigate the effects of various teaching procedures on vocational skill and concept learning by handicapped students. The report is divided into five principal chapters (sample subtopics in parentheses): vocational education for the handicapped (mainstreaming): a review of concept learning research (learner characteristics, characteristics of the learning environment, media and concept formation): methodological procedures (instructional material development): presentation of the findings from eight substudies (including the influence of group size, presentation mode, and advanced organizers on concept formation): and application of the study in a paper by M. Hull et al., "Teaching Vocational Skills and Concepts to Students with Special Needs." Extensive appendixes present pictorial analyses and scripts of lesson formats and information on instructional materials. (CL)

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TEACHING VOCATIONAL CONCEPTS
TO THE HANDICAPPED

Grant G00 77 00628
Final Report of ~~Project~~ Number ~~443CH70268~~

A Study of the Acquisition of Employment-
Related Concepts by Mentally
Handicapped Students

Funded by the Bureau of Education for the Handicapped
U. S. Office of Education

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FOREWARD

In recent months, much attention at many levels has been given to improving employment opportunities for the handicapped. Federal, state, and local initiatives have been launched in a concerted effort to secure jobs for handicapped persons, both through open competitive routes and through affirmative action programs. In response, the fields of education and vocational rehabilitation have stepped up their efforts to help handicapped persons to qualify for increasing employment opportunities.

Education's involvement in preparing the handicapped for employment is multifaceted, extending across all grade levels and including career education, industrial arts, vocational education, related academics, career guidance, on-the-job training, cooperative vocational education, work-study, vocational clubs, and more.

Ideally, for every stage of intellectual and social development, educational activities will be planned which help to prepare a handicapped child's hands and mind for the time when they will be able to perform skilled tasks which are essential to, sought after, and rewarded by industry. The achievement depends on many factors.

Teachers and parents must get into the practice of writing appropriate career development goals and objectives into each Individualized Education Program developed for a handicapped child. School administrators must arrange for sufficient programs and resources to accomplish the state career goals and objectives. State education agencies must ensure that adequate funding is available for career development programs, that staff are appropriately trained, and that appropriate coordination exists between special education, vocational education, and school guidance.

A less obvious factor, but one of no less importance, is the need for teachers to be able to effectively teach handicapped persons the vocational concepts and skills which lead to employment.

This publication reports the outcomes of a series of research activities which were carried out for the purpose of studying the impact of various teaching procedures on the learning of vocational skills and concepts. The authors of the report recognize a strong need to verify promising instructional techniques which can be used by vocational and practical arts teachers in teaching vocational skills and concepts to handicapped students, whether in regular or in special vocational programs. For this reason, the report focuses more on the broad application of the research than on the technical presentation and analysis of the data.

The report is divided into five principal chapters:

1. Vocational Education for the Handicapped
2. A Review of Concept Learning
3. Procedures Used in the Study
4. Presentation of the Findings
5. Application of the Study

A mini-report has been prepared as a companion volume to this final report. The mini-report summarizes the strategies that can be used to improve vocational instruction for persons with learning handicaps. Copies of either report may be obtained while the supply lasts by requesting them from the Center for Career Development and Occupational Preparation, College of Education, Texas A&M University, College Station, Texas 77843.

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Terms Used in the Report

Handicapped: As used in this report, the term "handicapped" refers to children who have been determined eligible for special education and related services according to state guidelines. There are 11 handicapping conditions specified in the regulations published by the U. S. Office of Education (August, 1977). The majority of handicapped students participating in this study come under two handicapping conditions, mentally retarded and specific learning disabled.

Vocational Education: As used in this report, vocational education refers to secondary programs in public high schools which are equipped and designed to teach skills leading to employment in industry, trades, commerce, or other enterprises requiring skilled labor.

Special education: As used in this report, this term referes to public school programs and services designed for handicapped children. The term also refers to specially designed instruction for handicapped children in general education classes.

Special Needs Students: The Publication Committee of the American Vocational Association (1976) has tentatively defined special needs students as "those persons who meet the criteria as handicapped or disadvantaged persons who require special programs, modification of programs, or supplemental services to help them succeed in a vocational education program".

Concept: Numerous scholars have attempted to define what a concept is. The lack of a universally acknowledged definition of the term makes if difficult to ascertain whether the various people who purport to be studying concept formation are actually studying the same phenomenon. For purposes of this study, Klausmeier and Ripple's (1971) definition of concept will be used: A concept is a mental construct, or abstraction, characterized by psychological meaningfulness, structure, and transferability that enables an individual to do the following: (1) cognize things and events as belonging to the same class and as different from things and events belonging to other classes; (2) cognize other related super-ordinate, coordinate, and subordinate concepts in a hierarchy; (3) acquire principles and solve problems involving the concept; (4) learn other concepts of the same difficulty level in less time (p. 402).

Concept Formation: According to Clark (1975), concept formation is the ability to correctly: "(1) identify the critical, semicritical and noncritical properties of a concept; (2) sort out or identify new instances and discriminators of a concept that are presented by the teacher; and (3) find new instances of the concept without help from the teacher" (p. 58).

Positive Instance: A stimulus item which exhibits all the critical properties of a concept in their appropriate relationship is a positive instance. This term is used inerchangeably in the literature with the terms "example" and "exemplar".

Negative Instance: A unit which according to Clark (1971) either contains or displays "(a) none or some but not all of the critical properties of a concept in their appropriate or inappropriate relationship, or (b) all the critical properties of a concept but in an inappropriate relationship" (p. 261).

Irrelevant Attribute: A property of any particular example which according to Markle and Tiemann (1969) can be varied without changing the example to a nonexample.

Relevant Attribute: Relevant attributes are those characteristics which according to Woolley and Tennyson (1972) are essential to the item for it to be classified as belonging to the concept. This term is used interchangeably in the literature with the terms "essential characteristic" and "critical property".

CHAPTER 1

BACKGROUND OF THE STUDY

There are many factors which contribute to the quality of life:

family,
friends,
recreation and sports,
music and the arts,
literature,
hobbies,
travel,
good health,
a clear perception of positive values,
nature and the ability to see and appreciate beauty in one's physical surroundings,
work...gainful and meaningful employment.

Work can contribute measurably to the quality of life as well as provide a means for securing some of life's essential commodities - food, shelter, clothing, transportation, goods, and services. Opportunities to work are vital to a majority of the population, including persons who are disabled.

Disabled persons themselves are beginning to speak out about the importance of work in their lives. Dr. Frank Bowe, a respected and dynamic leader of disabled citizens speaks of the important of work in his provocative book, Handicapping America:

> Employment can provide deep personal satisfaction and feelings of self-worth, daily stimulation and challenge, monetary compensation, important fringe benefits, social interaction with a wide variety of people, the opportunity to produce and to create, recreation and enjoyment, and a constant impetus to further personal and professional growth. Enforced idleness, by contrast, denies feelings of self-worth, reduces opportunities for human growth through exposure to new experiences, produces bare subsistence-level living, and may instigate intense feelings of self-hatred and disgust. (p. 65).

Presently, much emphasis is being placed on improving vocational training opportunities for handicapped youths. In doing so, many barriers have been brought to light.

Too often, for example, handicapped youths - both those who are enrolled in special programs and those who are able to participate in mainstream programs - have been forced to enter an incredibly complex world of work without ever having experienced how it feels and what it means to successfully:

solder components on an electrical circuit board,
adjust the idle speed screw in a carburetor,
cut a dodo joint using a table saw,
take a blood pressure reading,
ignite an oxyacetylene torch.

By way of contrast, no educator would place a five year old learning disabled child in a library carrel and say, "When you figure out how to read, you may come out." Nor would an educator, when beginning to teach a 19 year old mentally retarded adult to drive, shove their car onto the Boston beltway and say, "When you figure out how to drive, you may come back to school."

On the contrary, most educators would say that to teach handicapped youths a complex cognitive skill such as reading or a complex motor skill such as driving that special materials, special instructional techniques, special equipment, special people, and, perhaps, a special time and place are needed. Thus, to expect mentally retarded and other learning disabled youths to succeed in today's complex world of work without special training and preparation in many regards is to expect handicapped children to read without first being exposed to written symbols or learning to identify and decode letters. Learning a skilled trade like learning to read or to drive involves the mastery of many sub-components: learning the name, function, and operation of tools and equipment, learning to discriminate materials which have many common properties, learning to manipulate raw materials through multi-faceted production processes, learning to judge texture, symmetry, size, color, weight, flavor, learning to measure, bend, cut, smooth, shape, and fasten materials. The list goes on and on.

For many disabled youths, learning complex technical skills can be a formidable task unless instruction is of high quality.

This point leads to the premise which underlies the research studies reported in this publication, namely this: the quality of vocational instruction will determine at least in part the success that handicapped youths will experience in learning a vocation. This report describes selected variables which influence concept formation and acquistion by mentally retarded and learning disabled youths.

To achieve the goal of the study, the following research objectives were formulated:

Primary Objective 1: To identify the extent to which selected factors identified in the literature influence the learning of occupationally-related praxiological (action-oriented) concepts by mentally handicapped students.

Sub-objective: To determine if mentally handicapped students learn an occupationally-related skill to a greater extent by (1) overt practice only, or (2) by a covert activity only, i.e., a mental rehearsal and verbalization of the steps to be followed in the task, or (3) a combination of verbal rehearsal and overt practice.

Primary Objective 2: To identify the extent to which selected instructional variables influence the acquisition and retention of vocational concepts.

Sub-objective A: To compare the performance of EMR students in a vocational concept acquisition task in which students are assigned to different instructional arrangements: small group instruction, and large group instruction.

Sub-objective B: To determine the influence on concept learning of active (live presentations) versus passive (audio-visual) presentation modes.

Sub-objective C: To determine the influence on concept learning of a high frequency of associative cues and analogies versus the absence of cues and analogies.

Sub-objective D: To determine the influence on concept learning of advanced organizers and overviews.

Primary Objective 3: To identify the extent to which the use of a paired-associate teaching paradigm differs from the use of a concept teaching paradigm in a vocational concept acquisition task for mentally handicapped students.

Primary Objective 4: To identify the extent to which the use of instructional materials which have been modified to include specific concept teaching strategies differ from the use of instructional materials which do not utilize concept teaching strategies in the acquisition of a vocational concept.

Primary Objective 5: To determine (a) the degree to which selected student characteristics are related to the successful employability of handicapped persons, and (b) the degree of correlation between instructors' and employers' ratings of selected student behaviors critical to employment (i.e., listens to instructions, follows directions, accepts criticism, dependability, pride in work, enthusiasm toward work, rapport with other employees) for mentally and physically handicapped students.

Primary Objective 6: To determine the extent to which EMR, LLD, and non-handicapped students differ from each other in the acquisition of vocational concepts.

Chapter two of this report reviews the literature relevant to vocational skills and concept learning. Chapter three discusses the research methods used in the studies reported in this publication. Chapter four describes the outcomes of the different substudies and discusses the implications of the various findings. The appendices include examples of the materials used in the research.

The remainder of this chapter discusses the background of the study and summarizes in a general sense the factors which contribute to successful instruction of handicapped youths in a vocational education context.

Vocational Education for the Handicapped

For many handicapped persons, vocational education presents a much desired but often elusive opportunity - the chance to train one's hands and mind to perform skilled tasks which are essential to, sought after, and rewarded by industry. The importance of vocational education lies in the fact that it focuses on the development of specific, saleable skills of a technical nature rather than the development of general employability skills as is frequently the case with other programs open to the handicapped.

Vocational education has much to offer handicapped persons, but leaders in vocational education too seldom have aggressively sought opportunities to serve this population, despite the oft quoted credo that vocational education is for everybody who desires to participate and can benefit from such participation. All too frequently the handicapped have not been viewed as suitable candidates for entry into the skilled trades. Hence, they have been persistently underrepresented in vocational education, both at the secondary and post-secondary level. Current estimates - much in need of wider confirmation and updating - place the proportion of handicapped persons participating in vocational education at less than 2%, with a majority of this enrollment assigned to segregated, special classes.

The underrepresentation of the handicapped in vocational education can be explained by a number of factors. For one thing, in some schools several persons have had to vie for a single program opening. Selection criteria, quite naturally, have favored those applicants most likely to succeed and most likely to be sought out for future employment, something of particular concern to vocational educators. Another explanation is that vocational teachers, though experienced and skillful in their vocations, often have had limited training in pedagogical matters, therefore have lacked certain skills needed to successfully accommodate individuals whose handicaps adversely affect learning. Technical assistance from special education, on the other hand, too frequently has been inadequate or lacking altogether. Any number of additional points can be raised to explain the underrepresentation of the handicapped in vocational education. Even so, it is the future of vocational education of the handicapped which should command the attention of advocates for the handicapped, not so much the past.

The handicapped are destined for several reasons to play an expanded role in vocational education. Gone are the days when accommodation of the handicapped could be regarded as an altruistic enterprise to be pursued at a vocational teacher's or administrator's personal discretion. Equal access to vocational education and reasonable accommodation once in vocational education have become a matter of law for millions of handicapped individuals. It is now up to school districts to seek out successful ways to appropriately provide equal access to all facets of vocational education: to regular programs, special programs, vocational guidance and counseling, youth organizations, cooperative vocational programs, and vocational work-study programs. Furthermore, efforts are being made by organizations like the American Coalition of Citizens with Disabilities to encourage the involvement of handicapped persons in advisory councils, curriculum development research, and exemplary program development. Advocates for the handicapped are actively beginning to monitor the extent to which local and state annual program plans and long-range planning documents adequately and appropriately speak to the needs and concerns of handicapped pupils.

For a decade or more, the participation of handicapped persons in vocational education has occurred largely in special classes, with the impetus and start-up funds for these classes coming from the 10% set-aside provisions of the Vocational Amendments of 1968. Special classes can serve multiple purposes such as providing a transition class in which students prepare for a successful entry into regular vocational programs, providing intensive (though limited) skills training prior to job placement through work-study, providing an accommodating environment for students who simply cannot adjust to the pace and pressures of regular classes, or providing highly specialized training for particular groups such as the deaf. Advantages not withstanding, special vocational classes present some obvious limitations.

Special classes isolate students from positive peer models, may make students overly dependent on teacher assistance, often do not sufficiently challenge students to perform up to industrial standards, proliferate projects and activities of little or no occupational signficance, afford very restrictive training in areas having no particular interest to students and having only limited employment potential. In some states, vocational teachers assigned to special classes are not required to have special training in working with [illegible] handicapped.

States which have proliferated the construction and staffing of special classes - even special facilities - must now reevaluate their purpose, especially in view of the least restrictive environment provisions of P.L. 94-482, 94-142, and 93-112 (Section 504). The use of special classes may need to shift to assessment and exploratory activities or to serve as transitional classes for integration into regular programs. Special facilities now used to train the mildly handicapped may need to be revised to train the moderately to severely handicapped for productive participation in non-competitive work environments.

Mainstreaming continues to be approached with considerable ambivalence on the part of many vocational educators, and some special educators, although federal regulations clearly stipulate that handicapped persons must have equal opportunities to participate in regular programs and explicitly direct public agencies to take positive steps to accommodate the handicapped in mainstream settings. Much in demand at this point are leaders in vocational education who can approach mainstreaming with openness. Otherwise, handicapped students and teachers may be subjected to many pointless frustrations and failures. The clear facts are that if handicapped students - whether mentally retarded, specific learning disabled, or seriously emotionally handicapped - are not taught vocational skills and concepts at an appropriate level and in an appropriate manner, the most willing and sensitive vocational instructor will experience failure. This is not to say that mainstreaming should be regarded as just another passing fad. Rather, a need is being expressed for approaching mainstreaming with utmost care and concern for everyone's welfare.

Mainstreaming in vocational education does not deny differences among individuals; it accommodates and appreciates them. The keys to successful mainstreaming include sensitivity, flexibility and understanding: sensitivity to individual differences; flexibility in the selection of objectives to be achieved, in the selection of performance standards, and in class and homework assignments; and understanding of the strategies to be used in getting information across to the students. Mainstreaming cannot condone an attempt to force handicapped students to perform at the same level as other students, rather it acknowledges the fact that handicapped persons have a constitutionally guaranteed right to participate with their peers and to benefit from the facilities, staff and instructional programs enjoyed by non-handicapped students.

Considerable research has been funded to identify the factors which determine successful mainstreaming in vocational education. Educators should be aware of these factors and encourage their consideration whenever possible through the following actions:

(1) Committees should be established to evaluate the appropriateness of existing programs for meeting the needs of the handicapped. Curriculum content, evaluation procedures, performance standards, and instructional approaches should be reviewed and potential problem areas identified, discussed, and when possible resolved.

(2) Activities should be devised to identify available jobs for the handicapped, to develop positive community support, and to encourage positive attitudes on the part of employers and school personnel.

(3) The roles of secondary school educators, vocational instructors and vocational guidance personnel should be clearly defined as they pertain to the development of Individualized Education Programs and as they pertain to eligibility criteria and selection procedures.

(4) Opportunities should be provided for vocational educators and special educators to meet on a regular basis to exchange information, evaluate program effectiveness, and discuss matters of mutual concern.

(5) Staff development opportunities and incentives should be provided, including field trips, college courses, inservice workshops, team teaching and conferences.

(6) Time and technical assistance should be provided to assist instructors to select appropriate instructional materials, content, and techniques. Time and assistance must also be provided for the modification of equipment.

(7) Supplementary services, needed to support students in regular classes, must be identified and provided to the fullest extent feasible, including consulting teachers (special education specialists) paraprofessional and volunteer aides, readers, interpreters, peer tutors, and guidance personnel.

(8) The curriculum may need to be analyzed to identify ways of extending it down to the entry level of students, while at the same time keeping it occupationally relevant. Alternative yearly or long-term goals may need to be identified together with multiple, but meaningful, exit points from a program.

Whether educators focus on extending quality experiences in regular programs or special programs, there is much to be considered and much to be gained. The handicapped can be successfully accommodated in vocational education and given genuine vocational training opportunities. The exemplary program models in both special and mainstream settings are in place. Special materials are available. Promising practices exist in large number. Remaining is the task of extending the benefits of vocational education to all handicapped students whose individualized programs call for it. Remaining is the task of helping every vocational instructor become aware of successful ways to teach technical skills to handicapped pupils.

Teaching Vocational Skills and Concepts to Pupils with Handicaps

This research project investigated very specific factors which influence vocational concept learning.

The classroom teacher seldom has an occasion to approach instruction in such a restrictive content as presented in this report. Ordinarily, classroom instruction calls for the manipulation of hundreds of variables. However, the findings of this research effort combined with the findings of other studies lay a foundation for successful teaching - teaching of a quality that even reluctant and limited capacity learners can learn a sufficient amount to function independently in the home, in employment, and in the community at large.

A few of the factors that ensure the successful teaching of vocational skills and concepts to mentally retarded and learning disabled students and discussed before the more specific and restrictive factors pertaining to this research effort are described.

Objectives: Instruction needs to be guided. One successful approach to guiding instruction is the specification of instructional objectives. Studies have shown that students who clearly understand the objectives which they are to master perform better than students who are not apprised of instructional objectives. Objectives help to guide the teacher's instruction as well, and give the teacher a criterion for asessing whether instruction has been successful.

Task Analysis: Researchers have demonstrated that persons with marked limitations in intellectual functioning can learn complex vocational tasks when these tasks are broken down into simple, concrete steps. Task analysis is the process of breaking complex tasks into simpler ones.

The object is to develop sequences of simple tasks which can be learned easily in a manner that ultimately makes it possible for the learner to perform a complex task without assistance. Gold, York, Brown, Bellamy, and numerous other researchers have demonstrated that very low functioning individuals can learn to assemble complex circuit boards, and ten-speed bicycle brakes, following instruction which is based on analysis principles.

Active Responding: For mentally retarded and learning disabled persons to learn vocational skills and concepts, they must be given opportunities to respond correctly and frequently. Arranging the instructional environment so that responses can be made frequently and correctly is an important step to aiding learning. There are seldom discipline problems or motivational problems in a learning situation where students are responding (or demonstrating skills) at a high rate and successfully. By breaking complex tasks into simpler ones, the rate of successful responding is increased and learning is more apt to be successful.

Feedback: When a task is being learned, it is often necessary to give the learner frequent feedback, that is, to keep the learner informed of the appropriateness of the responses being made. Repeated responding and repeated feedback may be necessary in learning tasks of a complex nature.

Learning Styles: Successful teaching calls for a high degree of student awareness. The successful instructor of vocational skills and concepts will have a clear picture of what each student knows and how each student learns best. This is done by observing, asking, and testing.

Students have preferred learning styles, and students have preferred learning environments. Concepts and skills can be presented in a clear and concrete manner, but if the pace of the instruction and the presentation mode is wrong for a given student, no amount of clear instruction is going to result in adequate learning.

Instructional Methodology

Research in instruction is an on-going process. Promising educational practices are being confirmed in the field all the time. It is important to keep abreast of these findings. Each State Department of Education is required to have a comprehensive personnel development system as a condition for receiving assistance under the Education of All Handicapped Children Act (EHA), part B. By contacting your local or state coordinator of special education, it may be possible to arrange opportunities to attend workshops in which promising educational practices are presented. Numerous journals are in circulation which present information on successful instructional approaches. The scientific aspect of teaching can be learned by almost anyone who is committed to creating a learning environment in which students experience success - over and over again. The remainder of this report gives an indepth look at some of the factors that make up a successful learning environment.

CHAPTER 2

A REVIEW OF CONCEPT LEARNING STUDIES

Concept learning is a complex phenomenon, involving many variables, only a few of which can be routinely manipulated in a classroom setting. Some examples of variables which have been noted to influence concept learning are summarized in Figure 1.

Figure 1

Examples of Variables Which Influence Concept Learning

Variable Category	Specific Variables
Characteristics of the Student	Age, IQ, Personality Traits, Academic achievement, Ambition, Self-concept, Preoccupations, Cognitive Style
Characteristics of the Learning Situation	Presentation Mode, Reinforcement Schedule, Group Size, Labels, Extent of Exposure, Instructional Atmosphere
Characteristics of the Concept to be Learned	Numerousness and Perceptibility of Instances, Concept Rule, Type of Instance, Concept Dimensions, Relevance of Attributes

The literature indicates that the efficiency with which concepts are learned depends to a large degree on the characteristics of the individual learner, the nature of the concept to be learned, the composition of the instructional setting, and the manner in which the concept is presented.

It is evident from a review of the literature that there are two basic approaches to concept learning--(1) the discovery approach whereby the learner, with or without guidance, discovers for himself the critical attributes and rules which identify a particular concept and (2) the didactic approach whereby the student is given explicit information that leads to concept formation. An excellent review concerning the relative merits of these two instructional approaches was made by Anderson (1970). This study, although carried out by researchers who recognize the merits of and the place for a discovery approach to teaching, focuses almost exclusively on the traditional didactic approach to the teaching of concepts, the approach most commonly used in industrial arts and vocational education classes.

Concept Learning in the Classroom

Concept learning as it relates to classroom instruction has been greatly benefited by D. Cecil Clark's (1971) comprehensive review and analysis of concept studies reported in the literature. Following a review of some 255 concept formation studies, Clark derived 61 principles of concept learning from what he called the "enormous stockpile of information" contained in the research literature. From his 61 principles, Clark wrote 16 prescriptions for teaching concepts in the classroom. Of his various prescriptions, Clark (1975) says that "the single most important step a teacher can take in teaching a concept is to identify its critical attributes" (p. 27).

Subsequent to the publication of his popular monograph, Clark made further studies on the implications of his 61 principles and 16 prescriptions for teaching concepts in the classroom. As a result of further research, Clark reduced his original set of 61 principles and 16 prescriptions to a set of 28 principles and 13 factors which affect concept formation. A discussion of Clark's revisions appears in a manuscript entitled: Teaching Single Concepts: Procedures Based Upon Experimental Research (1975).

Klausmeier and associates at the Center for Studies in Cognitive Learning (University of Wisconsin-Madison) have amassed an extensive body of research in concept learning. They have formulated a tentative theory of concept learning which is discussed at length in Conceptual Learning Theory (1974). In this publication, Klausmeier, et al. describe the attributes presumably belonging to all standardized concepts which make it possible to learn concepts. The attributes which Klausmeier et al. have identified account in part for the relative ease or the difficulty with which certain concepts are learned. Included among these attributes are:

1. Learnability: the relative ease with which a concept is learned (this can be determined for particular populations through the use of an instance probability analysis).
2. Useability: the application that can be made of a concept in problem-solving, forming additional concepts, and reducing the complexity of one's environment.
3. Validity: the extent to which experts agree on the definition of a particular concept.
4. Generality: the number of subclasses and subordinate concepts which a concept encompasses.
5. Power: the extent to which a concept facilitates the acquisition of additional concepts.

6. Structure: the rule by which the attributes of a concept are related to each other.
7. Perceptibility: the extent to which a concept can be sensed.
8. Numerousness: the relative number of instances of a concept that can be observed or imagined.

Variables Affecting Concept Learning

Even in carefully controlled laboratory settings, it is difficult to account for many of the factors which influence the acquisition of concepts. In the typical classroom setting, these factors are so numerous that they can seldom be isolated for careful study. Among the factors that have been studied are the characteristics of the learner, characteristics of the learning situation, and charactertistics of the concept to be learned.

Characteristics of the Learner

Other things being equal, the characteristics of the learner will often determine the efficiency of performance in a concept learning task. Certain learner characteristics, such as IQ, socio-economic status (SES), and age have been found to influence the rate and efficiency of concept learning. For learners of all ages, intelligence has been found to be an accurate predictor of concept formation (Jacobsen, Millham, and Berger, 1970; Marx, 1970; Laughlin, Doherty, and Dunn, 1968; Piland and Lemke, 1971; Switzky, 1973; Denney, 1973). The effects of SES on concept learning have been investigated, but the findings are inconclusive. Guthrie (1971), Nazzaro and Nazzaro (1973) reported that high SES subjects learned certain concepts more efficiently than low SES subjects. Securro and Walls, (1971), however, found that concept attainment was not affected by SES. Age, like IQ, has been found to correlate positively with the rate and efficiency of concept learning (Johnson, Warner, and Silleroy, 1971; Schalder, 1973; Nolan, 1974).

When concepts must be inferred from a set of stimulus cues, impulsive students have been noted to require significantly more trials to solution than reflective students (Brigg and Weinberg, 1973; Denney, 1973; Reid, 1974). Berquist and Klemm (1973) found that low-anxiety students (on the "Welch Anxiety Scale") acquired concepts more rapidly than did high-anxiety students.

Hollenberg (1970) found that high-imagery students were superior to low-imagery students (matched for sex, age, and IQ) in the initial learning of the names of objects.

Using a bisensory digit-span task, Ingersoll (1970) identified "visual attenders" and "aural attenders". When the preferred visual or auditory dimension was relevant to the solution of the task, Ingersoll found that it significantly influenced levels of concept attainment.

Davis and Klausmeier (1970) found that cognitive style also influences concept formation. Individuals whom the authors identified as high-analytic persons solved concept-identification problems with greater ease than did low-analytic persons. Moreover, it was learned that pretraining procedures could be used to ameliorate the disparity between high scoring students in an embedded figures test and low scoring students.

Awareness of the effects of various learner characteristics on concept learning coupled with a knowledge of the specific strategies for minimizing or maximizing these effects should make it possible for teachers to improve concept learning.

Characteristics of the Learning Situation

Considerable research has been done to determine the influence on concept learning of various factors which can be manipulated through deliberate instructional planning. McMurray (1974) investigated the effect on concept learning of four presentation conditions: (1) the use of a wide variety of concept instances combined with the use of multiple presentations; (2) the use of a wide variety of concept instances together with a single-instance presentation; (3) the use of a narrow variety of concept instances combined with the use of multiple presentations and (4) the use of narrow variety of concept instances together with a single-instance presentation. Sixteen subjects were assigned to each treatment. Test items were constructed to measure the ability of the subject to select positive examples of a concept from an array of closely related non-examples and to correctly classify previously unencountered examples of the concept. In an analysis of the data, all differences were in favor of the superiority of the wider variety of concept instances for "effecting significantly more correct classifications of previously unencountered instances than did the narrow variety repeated" (p. 57). In citing the significance of her study, McMurray made the following observations:

> First, the individual classroom teacher who is looking for the most effective manner in which to present a concept would clearly select as wide a variety of instances feasible within available resources and resource materials. Second, if time constraints were such that only a certain number of instances could be presented, presentation of a wider variety of concept instances . . . rather than repetition of only a few would be most likely to promote better concept learning. Third, when using a wide variety of concept instances, the teacher would match examples with nonexamples or irrelevant attributes and present them together as matched pairs in order to focus student attention on the only differing and relevant attribute (p. 68).

In a study of trait-treatment interaction between general aptitude and instructional media, Snow and Salomon (1968) found that low-ability students acquired concepts more rapidly and with better recall with live presentations than with passive (film) presentations.

The effect of varying the amount of detail in a pictorial presentation of a concept was studies by Gorman (1973), who found a lack of significant differences in performance in relation to (1) the amount of pictorial detail (line drawings versus detailed drawings), (2) presentation strategy (successive presentations of single instances versus simultaneous presentations of multiple instances), and (3) grade level (fifth graders, ninth graders, and fifteenth graders). A 3 x 2 x 2 (grade level x pictorial detail x presentation strategy) factorial post-test-only design was used. Mean scores across the three grade levels for minimum pictorial detail (9.3, 9.3, 10.6) were not significantly larger than were the mean scores for maximum pictorial detail (9.2, 8.9, 9.7). This trend held for both a simple concept and a complex concept.

Nelson (1972) found that greater visual detail may be needed when ambiguous concepts are undergoing the process of differentiation. As students become more familiar with a concept, however, Nelson observed that less visual details may be needed to correctly classify the concept.

In an analysis of eleven studies reported in the literature, Nielson (1970) found seven studies (for tasks involving recall, recognition, and concept learning) in which pictorical stimuli were superior to verbal stimuli, two studies in which verbal stimuli were superior to visual stimuli and two studies in which no significant differences were noted. Caput (1974) notes, however, that a careful analysis of the findings of such studies suggests that the superior effectiveness of pictorial modes over verbal modes is a function of the concreteness or abstractness of the subject matter. Similar findings of the superiority of pictorial versus verbal stimuli have been noted in paired-associate tasks (Sampson, 1969; Wicker, 1970; Rowe, 1972). Superiority of the pictorial mode tends to disappear, however, when conveying content which has non-concrete characteristics.

Based on a review of previous research, Lewis (1970) concluded that below average students learn concepts better through pictorial presentations and profit more from pictorial multiple-choice test options than from verbal presentations and verbal multiple-choice test options. She concluded further that for complex, complicated concepts the best mode of presentation is a visual demonstration.

Yoder and Forehand (1974) found that modeling and verbal cues used singularly or in combination can facilitate the learning of difficult conceptual tasks for both retarded and non-retarded subjects. Further, their research suggested that retarded children use behavioral modeling and verbal cues in the same manner as non-retarded children. Litrownik, Franzini, and Turner (1976) found that modeling is an appropriate procedure for teaching both complex and easy concepts to trainable mentally retarded children. Litrownik et al. concluded from their research efforts that modeling should always include a verbal explanation of the concept to be learned. These researchers found that massed demonstrations (twelve consecutive presentations without practice) were superior to distributed demonstrations (ones in which the model's demonstration is immediately followed by participant practice) if the instructional goal is transfer of training or is generalization.

A popularly held assumption is that certain students learn concepts more effectively from "real" objects which can be manipulated than from pictorial representations of the same concepts. Numerous researchers taking this position advocate a liberal use of concrete objects in the teaching of concepts to younger children. For college students, Fishkin and Pishkin (1970) found no significant differences between tactual and visual modalities for processing information, provided that the stimulus dimensions in the discrimination task could be discriminated both visually and tactually.

Baker and Popham (1965) designed a study in which groups of students enrolled in a teacher preparation program at the University of California were presented identical sets of instructional materials, with the exception that one set of materials had pictorial embellishments (cartoons, etc.). Post-test data indicated that the embellishments made no significant difference in efficiency of achievement. There were, however, significant differences favoring the embellished version in an affective rating of the materials by the students. In a related study, Levie and Dickie (1973) noted significant benefits of organizers which direct the attention of learners to relevant concept attributes.

Caput (1974) made a study of the comparative effectiveness of four different visula-verbal presentation modes. The four modes--Spoken verbal (S); Printed verbal (Pr); Spoken verbal with printed verbal (SPr); and Spoken verbal with still pictures (SP)--were examined in each of two experiments in which a randomized post-test-only design was used. As a dependent variable, Caput used three objective criterion tests to measure three cognitive learning tasks: learning facts, following procedures, and classifying concepts. Following an analysis of the data dervied from his study, Caput drew the following conclusions:

> 1. . . . the sound/pictorial mode tended to be the most effective mode for classifying concepts.
>
> 2. . . . presenting nonredundant information simultaneously through both audio and visual channels resulted in higher levels of performance than through either channel alone.
>
> 3. Providing relevant pictorial cues rather than presenting verbal information alone produced high performance in learning facts and classifying concepts.
>
> 4. Audio and print forms tended to yield equally effective levels of performance on cognitive learning tasks.
>
> 5. Pictorially-supplement presentations produced higher levels of achievement on pictorial tests than did verbal-only presentations. (p. 91)

Several studies have been made to investigate the relative superiority of the auditory and visual sensory channels. The superiority of either channel appears to some extent to be task specific, that is, to be related to the nature of the task to be performed. Under circumstances of high redundancy, the combined use of both the auditory and the visual channel appears to be superior to either channel alone (Hsia, 1968; Hartman, 1961). Otherwise, studies which have found visual presentations superior to aural presentations (Schulz and Kasschau, 1977; Van Mondfrans and Travers, 1964; Baker and Payne, 1969) are counter-balanced by studies which have found the superiority associated with the auditory mode (Margrain, 1967). Ann Lewis (1970) notes several advantages and disadvantages of both types of presentation modes:

> 1. . . . The visual presentation alone is capable of teaching a concept . . . Verbal presentation facilitates a need for knowledge of technical vocabulary; and uses less time. . . A difficult concept is best taught through a visual presentation.
>
> 2. With regard to sheer quantity of sensory response, verbal stimuli, because of their less restrictive nature, are superior to visual stimuli.
>
> 3. Pictures are more easily remembered than words due to their more distinctive characteristics.
>
> 4. The efficiency of visual presentations in learning decreases with age.
>
> 5. Certain types of words (verbs) accompanying pictorial presentations are more effective in aiding teaching.

When concepts are presented via audiovisuals, Razik (1971) found that concept learning can be impaired by allowing an insufficient amount of time for students to attend to cues which are presented audiovisually.

Another variable having a significant effect on concept learning is the mode of responding. Rowe (1972) found that verbal responding during a discrimination learning task was superior to non-verbal responding (pushing a button) for college students. In a replication of the study with fourth grade subjects, Rowe again found differences which favored a verbal over a non-verbal response mode, but the differences fell short of the .05 level of significance. Facilitative effects of verbalization in concept learning tasks have also been noted by King and Holt (1970) and Osler and Madden (1973). Lewis (1970) summarizes the effects of verbalizing in the following manner:

> 1. Verbalizing the correct dimensional value facilitates shifting.
>
> 2. With very young children, verbalizing the correct response was better than no response.
>
> . . . .
>
> 5. With familiar material, overt responses are insignificant in facilitating problem-solving.
>
> 6. Speaking-first training, as opposed to listening-first training, best facilitates learning.
>
> . . . .
>
> 8. While overt verbalization facilitates concept attainment, the explanation for this is unknown. (p. 273)

Reinforcement of correct responses has been found to increase both the rate of learning concepts and the efficiency of learning them (Bucher, 1973; Viel, 1975; Silver, Saltz, and Modigliani, 1970; More, 1969; Siegel and Downey, 1970; Cahoon, 1970). There appears, however, to be uncertainty about the manner in which reinforcement should be given. Cahoon found superior results with an intermittent feedback schedule; others have found continuous feedback to be superior. Negative reinforcement has been found by some to be superior to positive reinforcement; others have noted the opposite. More (1969) found delayed-feedback to be superior to immediate-feedback. Bucher found that the benefits of reinforcement were diminished when a competing reinforced activity was also available. Smith (1975) made an interesting finding: In a concept learning task, students assigned to a feedback and practice condition did significantly better than students assigned to a practice-only treatment. The effects of providing cues, examples, practice, and feedback were found to be cumulative with the best performance done by the group receiving the combination.

Feedback given during a concept learning task (usually referred to as prompting) has also been shown to facilitate concept attainment (Merrill and Tennyson, 1971). However, Hardman and Drew (1975) found that the greater the reinforcement in a concept learning task the less the rate of incidental learning.

The use of labels in concept learning has also been studied in depth. Providing highly meaningful labels facilitates concept attainment to a greater extent than low meaningful labels (Frederick and Klausmeier, 1968; Stones, 1970; Stephens, 1968; Kofsky, 1967; Di Vesta and Richards, 1970; Rosenthal, Alford, and Rasp, 1972; Gagiulo, 1974). Etaugh and Averill (1971) found that student-produced labels for stimuli in a discrimination learning task were not superior to experimenter-imposed labels--provided the latter were meaningful to the student. Dickerson (1970) found that the learning of distinctive names (labels) for relevant cues in a discrimination problem was superior to the learning of labels for both relevant and irrelevant cues.

Gargiulo (1977) investigated the effects of verbal labels only and labels plus instruction using a concept attainment task and a research population consisting of educable mentally retarded and normal male subjects of high and low mental age. One hundred sixty subjects, eighty EMR boys and eighty non-retarded boys, were stratified into high and low MA groups and were instructed in the concept of equilateral triangle. It was found that high MA subjects performed significantly better than low MA subjects although the retarded subjects did not differ significantly as a group in their performance from the nonhandicapped participants. It was also found that the subjects who received instruction plus verbal labels performed significantly better than students who received verbal labels only or a control group which received a placebo lesson.

Although not widely examined, researchers have sought to determine the effects of grouping on concept learning tasks. Klausmeier (1974) found that students in groups inferred concepts in fewer trials than students working individually. Piland and Lemke (1971) found no significant difference in learning efficiency for either homogeneous or heterogeneous grouping conditions. In a later study, however, Lemke, Leicht, and Miller (1974) found that for low-ability students, training to induce a particular concept in a heterogeneous group setting resulted in better transfer performance than did training in a homogeneous group of other low-ability students. The authors presumed that the verbalizations of extroverts of high ability in the heterogeneous group facilitated the acquisition of solution strategies for the low-ability students.

Just as feedback influences concept learning so does pre-instructional activity. White, Richards, and Reynold (1971) found a significant inverse relationship between the number of pre-training problems students received and the number of trials required to reach criterion.

Moore, Hauck, Biddle, and Houtz (1973) found that the acquisition of concepts was improved by the imposition of a risk condition--loss of reward for incorrect performances.

Weisberg (1970) found that "advance organizers" (introductory lessons on the concepts to be presented) facilitated the learning of concepts. Similarly, Viel (1975) found that a pre-instructional explanation of the use of instructional objectives significantly influenced the attainment of concepts.

Concept Variables

The particular characteristics of a concept predetermine in part the ease or difficulty in which a concept will be learned. Some concepts, for example, can be easily learned from definitions alone, provided the meanings of the definitions are accessible to the student (Anderson and Kulhavy, 1972). Other concepts are more readily learned from the combinations of definitions and actual examples (Feldman, 1972). Some concept attainment tasks are facilitated by the use of non-examples, others by the use of positive examples, still others by combinations of positive and negative examples (Tennyson, 1973). Markle and Tiemann (1973) have found that positive instances produce significantly better generalization than negative instances and that negative instances produce significantly better discrimination than positive instances.

Clark (1975) has found that the more critical attributes a concept has the more discriminators (closely related non-examples) it is likely to have, hence the more precise the teaching must be in order to prevent misconceptions. For this reason, Clark distinguishes between negative examples which differ from a concept by only one attribute or dimension and negative examples which differ along several dimensions. When concept examples must be distinguished from closely related non-examples, Clark emphasizes the importance of drawing attention to the single attribute on which a concept and its discriminator(s) differ. Houtz, Moore, and Davis (1973) have had findings similar to those of Clark.

Not only does the type of instance influence concept learning, the number and type of attributes of an instance likewise influence concept attainment. A linear increase in the number of instances to solution and performance errors has been reports as a function of increasing numbers of attributes (Looney and Haygood, 1968; Laughlin, Chenowith, Farrell, and McGrath, 1972; Granzin, 1975).

Houtz, Moore, and Davis (1973) found that in a nondimensional concept learning task, when the relevant attributes remain constant across instances, the most efficient learning occurs when all of the irrelevant attributes are changed. When the relevant attribute changes from one instance to the next, as in the case of alternating positive and negative instances series, the most efficient learning occurs when the irrelevant attributes remains constant.

When presenting a definition as a concept, Markle (1975) found that the technique of setting apart the critical attributes on separate lines produced better learning than did a linear prose presentation of the same words.

Several studies have found that increasing the number of irrelevant attributes across instances inhibits concept learning because it reduces the capability of students to attend to and utilize the relevant attributes of the stimuli (Amster, 1966; Edmonds and Mueller, 1970; Scandura and Voorhies, 1971). Similarly, Champione and Beaton (1972) have found that the magnitude of transfer from one task to another is in part a function of the similarity of stimuli.

Tennyson, Woolley, and Merrill (1972) found the following:

1. The combined use of high- and low-probability exemplars matched (irrelevant attributes of exemplar and nonexemplar are as similar as possible) and divergent (two exemplars with irrelevant attributes as different as possible) resulted in correct classification.
2. The use of low (or all levels), unmatched, and divergent exemplars resulted in overgeneralization.
3. The use of high-probability exemplars, matched and divergent resulted in undergeneralization.
4. The use of all levels of probability exemplars, unmatched and convergent exemplars resulted in misconceptions.

Media and Concept Formation

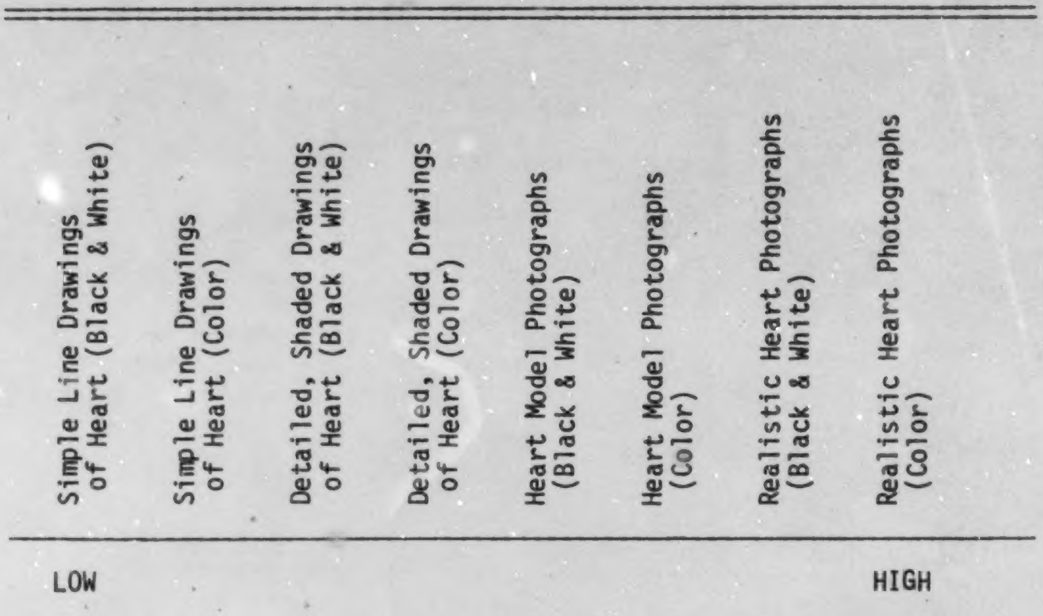
The systematic management of instructional materials has been shown to have a pronounced effect on the learning of concepts (Frase, 1975; Merrill and Boutwell, 1973; Baker, 1973; Levie and Dickie, 1973). The type of concept to be learned determines in part the appropriate type of media to convey the concept. Several models have been devised for making decisions relevant to the selection of media (Tosti and Ball, 1969; Van Mondfrans and House, 1970; Dwyer, 1972). While the models differ in some respects, the majority of them entail some type of scheme for matching the attributes of the medium, the characteristics of the learner, the attributes of concepts to be taught, and the instructional objectives to be attained.

The researcher who chooses to examine the effect on learning of various types of visual illustrations faces the problem of trying to conclude whether one stimulus item actually conveys information in a more efficient manner than another item or whether one type of illustration simply illicits a higher rate of attending (orientation to the task at hand) with the possible consequence of a greater rate of learning. At Pennsylvania State University, Francis Dwyer has been conducting studies since 1968 on the instructional use and effectiveness of various visual illustrations. In his Guide for Improving Visualized Instruction, Dwyer (1972) presents a realism continuum for visual illustrations. His continuum is based on the following rationale: "The more qualities a visual has in harmony with the object or situation which it is to denote, the more realistic the visual is said to be" (p. 5). Based on this rationale, Dwyer developed a series of visual illustrations to accompany a 2,000 word instructional unit on the human heart. Dwyer ranked his visuals as shown in Figure 2.

In a series of studies utilizing college students, Dwyer held a 2,000 word script constant but varied the visual stimuli for different treatment groups. His intent was to determine the effectiveness of the various visual stimuli in facilitating learning. His dependent variables consisted of four individual criterial tests (an 18-item drawing test, a 20-item identification test, a 20-item terminology test, and a 20-item comprehension test) for a total of 78 items which were designed in Dwyer's

Figure 2

Visual Presentation Formats Used
In the Dwyer Study (1968)


Simple Line Drawings of Heart (Black & White)
Simple Line Drawings of Heart (Color)
Detailed, Shaded Drawings of Heart (Black & White)
Detailed, Shaded Drawings of Heart (Color)
Heart Model Photographs (Black & White)
Heart Model Photographs (Color)
Realistic Heart Photographs (Black & White)
Realistic Heart Photographs (Color)
LOW
HIGH

words "to measure the student's total understanding" (p. 19). In terms of strict statistical significance, Dwyer found black and white line drawings to be the most effective of the various presentation formats; he also found significant interactions between his dependent variables (criterial tests) and certain types of visual illustrations. Because of this observed interaction, Dwyer concluded "that the realism continuum for visual illustrations, when used to complement oral instruction is not a realiable predictor of learning efficiency" (p. 22). But he did add that generally speaking "the more realistic illustrations were found to be the least effective in complementing oral instruction" (p. 22).

Factors Which Influence Paired-Associate Learning

One of the sub-studies reported in this publication deals with paired-associate (PA) learning by mentally retarded students. A large number of PA studies have compared the performance of retarded subjects to that of non-retarded subjects.

Stein, Gambel, and Budoff (1973) conducted a study of paired associate learning in a EMR population to determine the relative effectiveness of different types of mediational strategies and different intervals between training sessions. Three training strategies were investigated . . . sentence mediation, visual imagery mediation, and a combination of the two. In each case, the subjects were shown a series of familiar pictures paired in such a manner that one served as a stimulus while the other served as a paired response. In the sentence mediation condition, the paired associates were presented and the subjects were given a sentence. One pair, for example, consisted of a leaf and an arrow. In this case, the subjects were given the sentence . . . "The arrow made a hole in the leaf.". In the visual imagery mediation condition, the subjects were told . . . "Now, close your eyes and try to make a picture of a leaf with an arrow through it.". In the condition which combined the two mediational strategies, the subjects were given the sentence and were also asked to visualized the arrow through the leaf as well. Intervals of one day, one week, and two weeks were allowed to elapse with randomly selected subjects given a post-test after one day, others given a post-test after one week and the remainder given a post-test after two weeks. Results showed that all treatment groups performed better than the treatment group which had not received mediational training. The group which received visual mediation training performed the best on the test which was administered one day after the training task; the group which received sentence mediation performed the best on a test administered one week after the mediational training; and the group which received the combined treatment performed best on the test which was administered after a two week interval. This research shows that there are important differences in learning that are caused by different training strategies. It further points out that the task to be performed following learning may in and of itself influence the type of instructional strategy that should be used when a concept or paired associate lesson is presented.

Turnure and Thurlow (1976) investigated the impact of verbal elaboration on paired associate learning of fifty educable mentally retarded children. Their research supported previous findings that paired associate learning is enhanced by embedding the noun pairs in familiar verbal elaborations. The researchers used three types of elaboration - functional, positional, and nonsensical. Examples of these elaborations appear below:

TYPE OF ELABORATION	EXAMPLE
Functional	The key is opening the door.
Positional	The key is in the jacket.
Nonsense	The key is jumping over the basket.

In the above case, the pair associates to be learned were, key-door, key-jacket, or key-basket. The latter condition (the nonsense condition) was assigned only to a control group. What Turnure and Thurlow found was that meaningful verbal elaborations do significantly improve the learning of a paired associate. Both functional and positional elaborations facilitated paired associate learning. Another variable examined by Turnure and Thurlow was familiarity versus unfamiliarity within a verbal elaboration. A familiar functional elaboration might be: "The key is opening the door."; an unfamiliar functional elaboration, on the other hand, might be: "The key is opening the wagon.". In the aspect of the study, it was found that both functional familiar and unfamiliar elaborations facilitated learning but that only positional familiar elaborations had a positive influence on learning.

Winters, Attlee, and Harvey (1974) found that retarded subjects learned to perform a series of paired associate (PA) tasks more effectively while using a study-test training procedure than when using an anticipatory training procedure. In the study-test procedure subjects were shown a series of stimulus cards in succession and were told during the presentation which response cards constituted a pair. This procedure was repeated until the students were able to select the appropriate response card when randomly presented with the stimulus card. In the anticipatory training procedure, the first set of stimulus cards and response cards were shown together as a pair and the subjects were told that the two cards belonged together. The stimulus card was then presented and the subjects were directed to select the correct response card. The stimulus cards were then randomly rearranged for the next presentation. In both training procedures, the stimulus cards were presented until one errorless trial was reached. As previously noted, the authors found that retarded subjects reached the desired level of performance more rapidly using a study-test training procedure than using an anticipatory training procedure.

Cspikes, Smouse, and Hudson (1975) designed a study to explore the influence of tangible reinforcement on the performance of retarded and non-retarded subjects in a pictorial paired associate task. Previous research had failed to consistently show a positive effect of reinforcement in PA learning. The Cspikes study consisted of two treatment conditions (tangible reinforcement and verbal reinforcement) and two groups (retarded subjects and non-retarded subjects). In a two-way analysis of variance, significant differences were found for both main effects. The group receiving tangible reinforcement had significantly more correct responses than the group receiving verbal reinforcement. Also, the non-retarded subjects performed significantly better than the retarded subjects. Cspikes et al. interpreted these results as meaning that tangible reinforcement should be used when attempting to increase correct responses in a simple paired associate task.

Motor Learning

One of the sub-studies described in this report compares two approaches of teaching a praxiological concept (action task) to mentally retarded and learning disabled students. For this reason, a number of motor proficiency studies of a related nature are reviewed in this chapter.

Plue (1972) cites numerous studies conducted between the years of 1950 and 1967 which point out the inferior psychomotor performance of mentally retarded individuals when compared with their age range non-handicapped peers. The majority of the studies surveyed by Plue deal with such tasks as finger dexterity, form perception, visual discrimination, spacial aptitudes and motor speed. Several of the studies reported by Plue show that retarded persons are able to be trained to a level that is equal to that of their age range peers. This finding has considerable significance in preparing the mentally retarded for the world of work in that it implies that a certain level of training would make it possible for these individuals to assume competitive jobs or jobs in the competitive labor market. Plue concludes the following: "It seems that the retarded, who are generally weak in psychomotor areas, can learn to do work-related motor pursuits and that once they are learned many seem to be retained. It could further suggest that experience (lack of practice) and education (opportunity to learn) are important parameters (p. 27)."

Scott (1971) conducted a study to determine whether educable mentally retarded children differed from non-retarded children in ability to acquire, retain, and relearn a gross motor skill. A balancing task was performed by the students and efficiency of learning was recorded using a stabilometer which measured to the nearest 1/100 of a second the amount of time a child could balance. Thirty-six EMR and non-handicapped children were randomly assigned to four groups (a) normal 16 balancing trials; (b) normal 24 balancing trials (c) retarded 16 balancing trials and (d) retarded 24 balancing trials. Following a 28 day period of no practice, each group received 16 additional trials which were referred to as relearning trials.

Scott found that the retarded children learned the skill of balancing on the stabilometer at the same rate as the non-retarded children but at an overall lower rate of performance. Learning was linear for all groups, that is, improvements in balancing resulted with successive trials. Following a 28 day lapse in training, the retarded group performed significantly lower than the non-retarded group, showing a significantly lower rate of skill retention. However, following 16 retraining trials the groups no longer differed in performance. Scott concluded that retarded students could perform a sufficient number of physical education skills to be integrated into regular physical education courses provided that extra practice time is made available for them to learn skills to an adequately proficient level.

Using a balancing task similar to Scott's (1971), Llewellyn (1972) compared the retention rates of EMR adolescents to a group of non-retarded subjects matched for chronological age and a group matched for mental age. The three populations were sub-divided into three groups which performed the balancing skill until they had achieved either 0, 50, or 100 percent of overlearning respectively. As in Scott's study, balancing performance was measured using a stabilometer. Llewellyn found no differences in recall between the EMR's and the chronologically matched group of non-handicapped students on delayed measures of 2 minutes, 1 week, 1 month, or 3 months. The EMR's rate of retention was superior to that of the group of students matched for mental age on delayed measures of 1 month and 3 months, otherwise there were no significant difference between these groups. Differences in recall were noted between the 100 percent overlearning group and both the 0 and 50 percent overlearning groups on the delayed measure of 2 minutes. The treatment groups did not differ, however, on delayed measures of 1 week, 1 month, or 3 months.

Stephens and Luddy (1975) found that motion pictures were superior to slides in teaching an action-concept (praxiological concept) to children of average or above average ability. Stephens and Luddy speculated that film instruction was superior to slides and superior to a live demonstration because the film instruction . . . "(a) depicts the actual actions and process, (b) presents the concepts in a systematic, relatively simple format, (c) effectively gains and keeps the children's attention, and (d) may be less emotionally-laden, because the pictures rather than the teacher are the focus of attention" (p. 280).

CHAPTER THREE

EXPERIMENTAL PROCEDURES

The preparations for this study occurred over a five month period and included such activities as (1) arranging with school administrators to conduct the study; (2) revising instructional materials and developing additional materials; (3) field testing the new materials; (4) developing and analyzing test items; (5) developing various subtests suitable for the matrix sampling procedure; (6) modifying computer programs for test scoring and for calculating multiple matrix sampling data; (7) securing parental permission for students to participate in the study and (8) making arrangements so that the study will cause minimum interruption to the normal school activities. The following account of the procedures used in the study is intended to assist vocational teachers or researchers to replicate portions of the study. Experimental procedures that are unique to a particular substudy are discussed in the next chapter. Only procedures of a general nature and applying to several substudies are discussed in this chapter.

Selection of School Districts to Participate In the Study

Altogether 16 school districts particpated in this research project. Formal permission to conduct one or more studies was obtained from each of the participating districts. The schools were selected in the following manner.

The principal investigator for the project described the purpose of the research at several summer workshops attended by vocational teachers of the handicapped and work study coordinators. Each teacher who indicated an interest in the study was given a special postcard which asked for information such as the number of students available and the name of the school administrator who should be contacted when making a formal request to conduct research. Teachers interested in the research were asked to return the cards only if they felt that their respective administrations would be supportive of the effort.

More than 30 positive replies were received within the first two months of the project. Each reply was followed up to ascertain the feasibility of conducting one or more sub-studies at the prospective sites. Calls were made to the chief school administrator or his or her designee and the purpose of the research and what it would entail was further discussed.

After this initial conversation, some school administrators decided to turn down the request. Some administrators considered the disruption to individual schedules (approximately one hour each for two successive days) too much for the benefits to be immediately derived. Others said it was a general policy not to allow outside research conducted in the school system (even though a teacher in their system was interested in the project and desired to participate). Some special education administrators who wanted to participate indicated that their vocational education administrative counterpart did not want to be involved in the study, and, therefore, turned down the request.

In a few instances, the researchers turned down the invitation to conduct one of the sub-studies in a school district because of an insufficient number of students or because the schedules of students involved in off-campus work-study programs made it impossible to randomly assign students to the experimental groups.

In the 13 school districts in which it was mutually decided to continue negotiating the research, a formal written request was submitted to the chief school administrator. In several instances, this request was then forwarded to a research committee for further consideration. Before granting formal permission to conduct the research, some administrators requested the submission of a formal mini-proposal.

After written permission to conduct the study had been obtained, forms were sent to the parents of all students from whose records confidential information was to be obtained. (Only a few of the sub-studies actually called for personally identifiable data.)

Before any study was conducted, at least one orientation meeting was held with the teachers whose students were to be involved in the research. The teachers were told the purpose of the study, the procedure to be followed, and the steps to be taken by the researchers to maintain the confidentiality of personally identifiable information. Special care was taken to discuss all matters that would influence the outcomes of the study and that would reduce the amount of disruption to normal routines caused by the research activities.

Experimental Procedures Followed In the Study

The general procedures followed in conducting the various studies reported in this publication are discussed in the following paragraphs. Specific research procedures and the experimental designs for each substudy are discussed in greater detail in the results section of the report.

Following a discussion of the study with the teachers involved in it, class lists were obtained. The combined class lists constituted the total pool from which a sample of students would be selected for participation in the study. The students were stratified by ability levels to the extent possible without having access to I.Q. scores or other indicators of ability. Where both educable mentally retarded students and students with specific learning disabilities were involved in a study, they were stratified so that an equal number of each category would be randomly assigned to the treatment groups. (In some cases, I.Q. scores were available, but only when parental consent had been obtained for release of confidentifal information.) The students were then randomly assigned to treatment groups.

The research called for two encounters with the students. At the first encounter, the students were told about the research project and what their participation entailed. Once the students were informed about the procedures to be followed and assured of how the various test results would be used, the pretest was administered. Because there were three different pretest forms, steps had to be taken to ensure that the pretests were assigned to the proper students and that the students fully understood the questions being asked. All pretest and posttest forms were preassigned to students based on their assignment to a particular experimental cell.

The pretest questions were read to the students by a trained and experienced researcher. In the majority of cases, only one individual administered the tests. The test groups usually consisted of no more than five to 15 students, all of whom were responded to the same subtest items.

Following the pretest, the students were thanked for their participation and the tests were collected. Each test booklet and each answer sheet were coded to ensure an accurate tabulation of the data by experimental group and by subtest form. The test booklets and answer sheets were assembled according to the preassigned code numbers and the instruments were stored in a locked room until the data was transferred to computer storage.

At the time of the second encounter (which in most cases took place on the following day or one week later), the students were given the instructional lesson. The lesson consisted of a booklet of line drawings or some equivalent material and was accompanied with a narrative. The narrative was read to the students in a manner that resembled a routine class presentation. Immediately following the lesson, the instructional materials were collected and the students were grouped in such a way that the three subtests could be administered as preassigned.

The posttests were then administered, collected, and assembled in the same manner as the pretests had been. The students were then thanked for their participation in the study and were allowed to ask questions about the experiment. Frequently, following the posttest the students were allowed to keep the pencils which had been given to them for the test.

Internal Validity

In an endeavor to ensure that the treatments were the cause of changes in student performance, attention was directed to certain extraneous variables in order to minimize or eliminate their effects within the experimental design, and thereby improve the internal validity of the design.

The random assignment of subjects to sample groups and the subsequent random allocation of these groups to treatment levels provided a measure of control against statistical regression. Random assignment also protected against the differential selection of subjects and effectively guarded against having one group with a higher entry level performance than other groups. The use of pretest scores as a covariant in the analysis of covariance provided a further safeguard against the effects of one group having a higher entry level performance than the other groups.

Random assignment helped to distribute randomly those students who had higher or lower intelligence or greater motivation to succeed in the tests.

External Validity

The random assignment of students also helped to control some of the potential confounding variables that could limit the external validity of the design. Interactive effects between the treatment and selection biases were partially controlled through random assignment of students to experimental cells.

Development of the Instructional Lesson

Several lesson formats were reviewed before one was selected for this study. Lesson formats designed by Becker, Engleman, and Thomas (1971); Markle and Tiemann (1969); Asbury (1971); Klausmeier, Ghatala, and Frayer (1974); and Clark (1975) were considered. Each instructional format was developed specifically for teaching concepts, and the effectiveness of each format had been documented through research. After considering the merits of each format, the one developed by Clark was selected over the alternatives because of its substantial theoretical base and because Clark (1975) himself said that this instructional format were "especially helpful in teaching concept to the mentally retarded" (p. II).

There are five principal components in Clark's format for teaching concepts: (1) identification of critical properties, (2) formation of an objective, (3) selection of materials, (4) presentation of the concept, and (5) evaluation of concept formation. Based on this format, a lesson plan was developed for teaching each of the concepts presented in the study. The lesson outline for one of the concepts, the standard flat head wood screw, is given below:

Lesson Plan for Teaching the Concept "Standard Flat Head Wood Screw"

I. Identification of critical properties

A. Critical properties:
1. A flat head with a straight slot across the diameter
2. A bearing surface that tapers inward toward the body
3. An upper portion of the body (approximately one-third of the body) with no threads
4. A lower portion of the body (approximately two-thirds the length of the body) with threads
5. A pointed base

B. Noncritical properties:
1. Type of metal or finish
2. Size of diameter or length

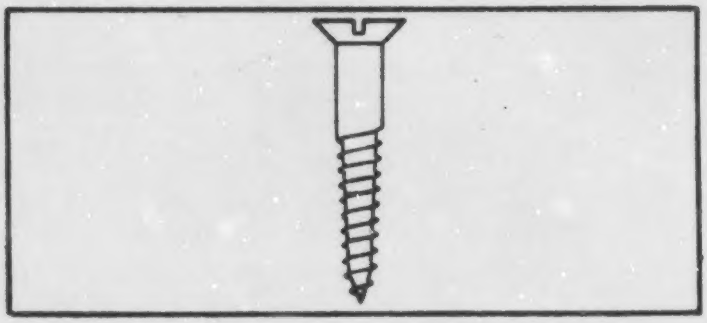
II. Formation of an objective

Following the completion of a prescribed set of instructional materials, the student will have formed the concept "standard flat head wood screw". As evidence of this, he will be able to:

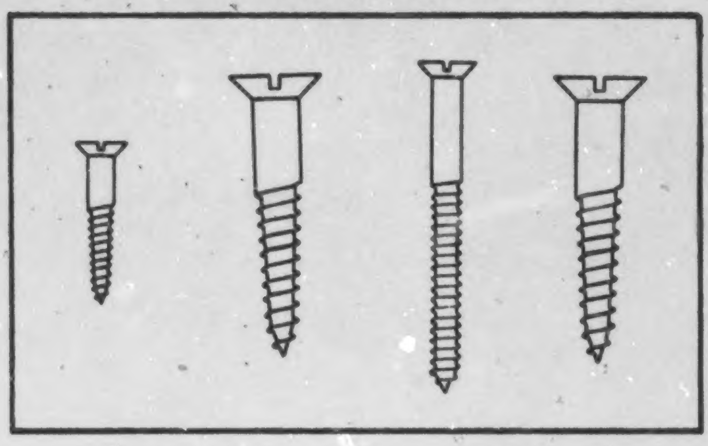
1. Discriminate positive instances of the standard flat head wood screw from other types of metal threaded fasteners
2. Distinguish between standard flat head wood screws and closely related concepts such as the flat head sheet metal screw, the flat head machine screw, and the flat head cap screw
3. Generalize across a group of positive instances and discriminators
4. Select new instances of the concept from an array of metal threaded fasteners

III. Selection of materials

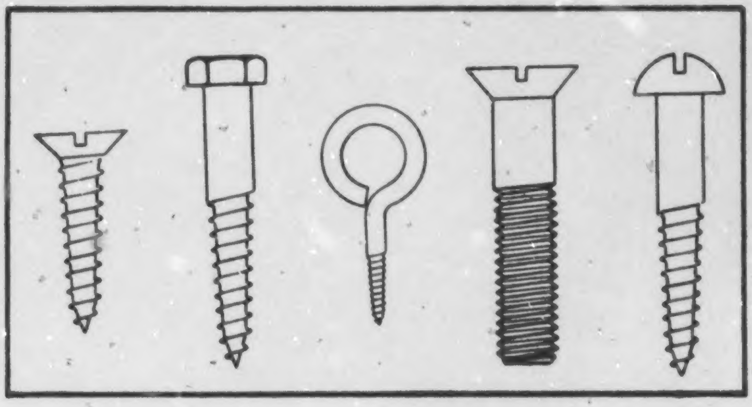
A. Positive instance for formative stage:



B. Positive instances for confirmatory stage:



C. Discriminators for formative and confirmatory stages:



IV. Presentation of the concept

A. (See Appendix A for a sample of the materials used)

V. Evaluation of the concept formation

A. Formative evaluation (See Appendix A for a sample of the materials used)

B. Summative evaluation (See Appendix A for a sample of the materials used)

The lesson format depicted in the preceding presentation was used to develop the instructional materials for five metal threaded fasteners. The same lesson format was used for the presentation of two other types of concepts, plumbing symbols and common cutlery. The lesson format for the common cutlery concepts was modified because knife functions, not names, were being taught. A second sample lesson outline concludes this discussion and reemphasizes the steps in preparing to teach a concept according to the prescriptions outlined by Clark.

Lesson Plan for Teaching the Concept "The Safety Valve Symbol"

I. Identification of critical properties

A. Critical properties:
   1. A set of two crossed lines
   2. A large "S" shape placed in the center of the crossed lines

B. Noncritical properties
   1. Size of symbol
   2. Color of symbol
   3. Type of end or pipe connection

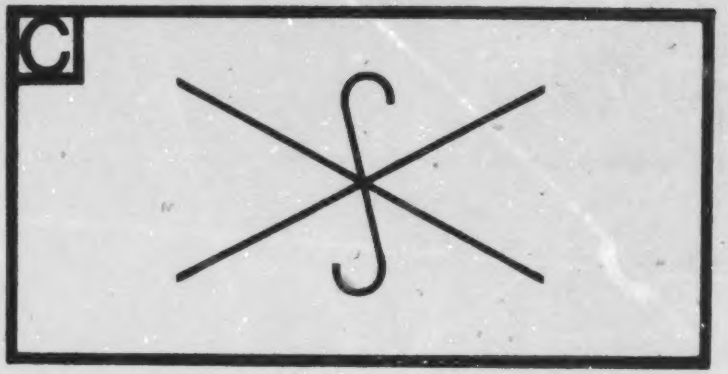
II. Formation of an objective

Following the completion of a prescribed set of instructional materials, the student will have formed the concept "safety valve symbol". To indicate learning of the concept, the student will be able to:

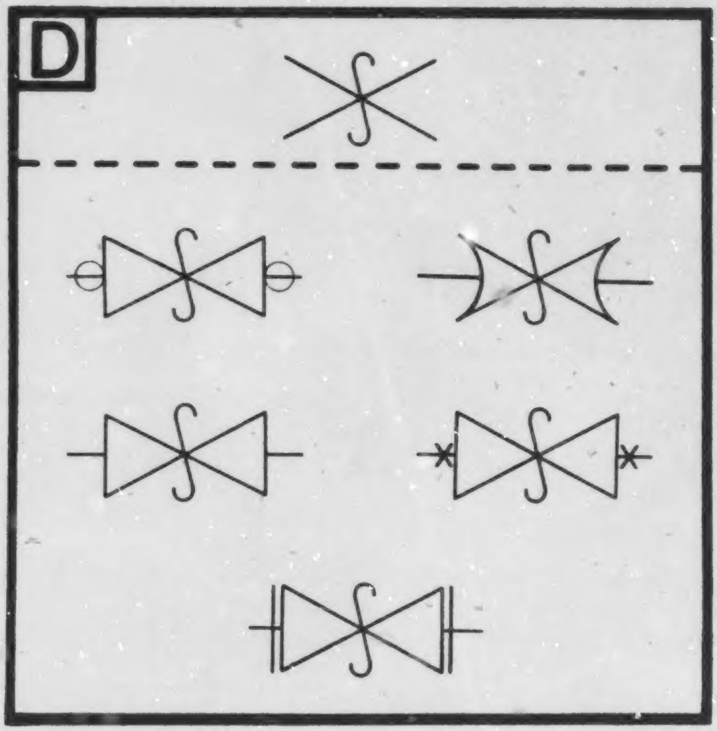
1. Discriminate positive instances of the safety valve symbol from other types of plumbing valve symbols.
2. Discriminate positive instances of safety valve symbols having various types of pipe joints (welded, soldered, and threaded) from other types of plumbing valve symbols having these various connections.

III. Selection of Materials

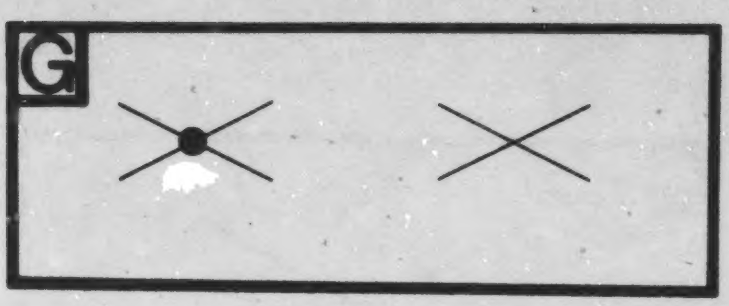
A. Positive instance for formative stage:



B. Positive instances for confirmatory stage:



C. Discriminators for formative and confirmatory stages:



IV. Presentation of the concept

A. (See Appendix A for a sample of the materials used)

V. Evaluation of the concept formation

A. Formative evaluation (See Appendix A for a sample of the materials used)

B. Summative evaluation (See Appendix A for a sample of the materials used)

The lesson format depicted in the preceding presentation was used to develop all the instructional materials used in this study. For a sample of the materials on common fasteners and common knives and their associated tests see Appendix A.

Development of the Instructional Materials

The development of the instructional materials for the study was carried out over a period of two months. The principal production techniques used in the development of the materials will be briefly described in this segment of the report. In order to carry out the several substudies, three basic sets of instructional materials were developed. Before developing the materials, several concepts were considered for use in the research. Finally, three different types of concepts were selected for use. Metal threaded fasteners were chosen as one type of concept; certain plumbing symbols were selected as the second type of concept; and the functions of common knives (cutlery) were chosen as the third type of concept.

Development of Fastener Materials

Metal threaded fasteners were selected because they were transportable and they could be graphically represented. Before preparing the materials to teach the various fasteners, an analysis was made of the critical and the noncritical attributes of each type of fastener. This was done so that examples which exemplified each of the noncritical attributes could be drawn. A standard reference text on fasteners was used as the basis for identifying the critical and noncritical properties of the fasteners. These included (1) the type of metal and finish used in the construction of the fasteners (hence the color was irrelevant) and (2) the diameter and length of the fastener. Although critical dimensions are associated with some of the fasteners, it was felt that because the fasteners normally can be purchased only within certain standard parameters that these attributes could be considered noncritical for purposes of the study. An analysis was made of the critical attributes of each fastener included in the study, a summary of which is given in Figure 3.

Figure 3

Critical Attributes of Five Metal Threaded Fasteners

Concept	Head	Bearing Surface	Body	Base
Hexagon Head Bolt	Hexagon-Shaped With Straight Sides	Forms Right Angle With The Body	Threaded Up To Two-Thirds of The Body	Pointed
Round Head Machine Screw	Rounded With Straight Slot or Recessed	Forms Right Angle With Body	Completely Threaded	Flat
Fillister Head Cap Screw	Slightly Rounded Head With Straight or Recessed Slot	Forms Right Angle With The Body	Can Be Wholly or Partially Threaded	Oval-shaped
Flat Head Wood Screw	Flat on Top Straight Slot	Sloping in Towards The Body	Partly Threaded Partly Unthreaded	Pointed
Hexagon Socket Set Screw	No Head, Socket Recess Cut Into One End	No Shoulders	Fully Threaded	Six Different Shapes Possible

Following the analysis of concept attributes line drawings were prepared. Line drawings ranging in size from 10 cm. to 17 cm. in length and 2 cm. to 4 cm. in diameter were drawn with the use of Rapid-O-Graph pens (numbers 00-4) and standard drafting instruments. The original drawings were mounted on a sheet of cardboard measuring 55.88 cm. by 76.20 cm. and were photographically reduced to 50% and 25% of their original size. From the reductions, ENCO 1250 metal plates were prepared for use on a 1250 multilith offset press in the production of master copies suitable for the development of the instructional materials. When assembled, the master copies were used to print packets of instructional materials using a 1250 multilith offset process (see Appendix A). Based on a review of the effects of visual emphasizers, it was decided to use arrows to direct the students' attention to the various critical attributes that would be emphasized in the instructional materials. Conservative use of these attention-focusing devices was based on the findings of Hartman (1961) that such devices "are of value only if they neither distract from learning which is already taking place nor continue in competition with the material to which they are supposed to direct attention" (p. 41). In addition, it was decided to enclose each of the instruction sets in distinctive frames with identifying letters affixed to the upper left corner. This was done to facilitate the coordination of the visuals with the accompanying lecture. The final product consisted of numerous frames, the content of which is summarized in Figure 4.

Development of Materials to Teach Plumbing Symbols

Following the preparation of the fastener materials, materials were prepared for teaching selected plumbing symbols. The same lesson format and drawing techniques were used in the preparation of the plumbing materials. Unlike the fasteners, however, the plumbing symbols (common valves) were more complex in nature, that is, a single symbol

Figure 4

Summary of Content for the Instructional Materials

	Total Number of Instructional Frames	Total Number of Positive Instances Presented	Total Number of Critical Attributes Taught	Total Number of Nonexamples and Discriminators Presented	Total Number of Formative Test Items	Total Number of Summative Text Items
Hexagon Head Bolt	13	15	5	8	10	9
Round Head Machine Screw	14	20	4	9	11	9
Filister Head Cap Screw	13	17	4	6	10	9
Flat Head Wood Screw	13	21	4	9	12	9
Hexagon Socket Set Screw	16	27	4	6	10	9
GRAND TOTAL	69	101	21	38	53	45

67 68

could convey multiple meanings. For example, the symbols used in this study have three principal components each of which represents a different set of items or functions. The middle part of the valve symbol denotes different types of pipe valves, either globe, safety, or gate valves (see Figure 5, page 58 for a summary of critical valve attributes). The ends of the symbols denote the type of joint or the process by which the valves are connected to pipelines. There are different symbols to indicate whether the joints are welded, soldered, or threaded. Finally, there are symbols indicating the types of the pipes to which the valves are conntected. There are symbols to indicate hot water pipes, cold water pipes, gas lines, air lines, and so forth. Thus in this material, a single visual representation could denote (1) tye type of valve, (2) the type of joint and (3) the type of or function of the pipe connected to the valve. These instructional materials are illustrated in Appendix A, and a summary of the content of the materials is given in Figure 6.

Development of Materials to Teach Knife Functions

Drawings and information brochures were obtained from Buck Knives, Inc., W. R. Case and Sons Cutlery Company, Ekco Housewares Company, and the Texas Agricultural Extension Service. After reviewing various brochures, seven knives were selected on the basis of their use as tools in the food trades area (a commonly taught cluster within vocational education). The critical and noncritical attributes were identified for each knife. In addition the functions of each type of knife were identified using standard references in cutlery.

FIGURE 5

Critical Attributes of Eight Plumbing Valve Symbols

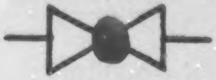
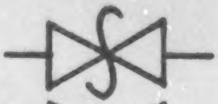
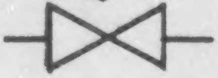
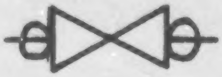
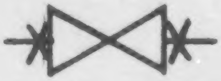
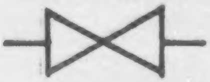
Concept	Critical Attribute	Examples	Non-Critical Attributes
Globe Valve	set of crossed lines with a large dot in the center where the lines cross		Size Material/Color
Safety Valve	set of crossed lines with large "S" shape in the cneter where the lines cross		Size Material/Color
Gate Valve	set of crossed lines		Size Material/Color
Soldered Joint	circles placed at each end of the valve symbol and over the lead-in lines of a valve symbol		Size Material/Color
Welded Joint	"X's" placed at each end of the valve symbol and over the lead-in lines of a symbol		Size Material/Color
Threaded Joint	a plain perpendicular connection between the valve symbol end and the lead-in lines		Size Material/Color
Hot Water Pipe	lead-in lines represented by a series of dashes separated by two dots	•• —— •• —— ••	Size Material/Color
Cold Water Pipe	lead-in lines represented by a series of dashes separated by one dot	• —— • —— • ——	Size Material/Color

FIGURE 6

Summary of Content for the Instructional Materials To Teach Valve Symbols

	Total Number of Instructional Frames	Total Number of Positive Instances Presented	Total Number of Critical Attributes Taught	Total Number of Nonexamples and Discriminators Presented	Total Number of Formative Test Items	Total Number of Summative Test Items
Globe Valve	8	15	2	4	15	5
Safety Valve	8	15	2	3	15	7
Gate Valve	7	14	1	4	15	5
Welded Joint	8	9	1	9	15	4
Soldered Joint	8	9	1	9	15	6
Threaded Joint	8	9	1	8	15	5
Cold Water Pipe	9	10	1	6	15	6
Hot Water Pipe	9	10	1	6	15	7
Grand Total	65	91	10	49	120	45

After the attributes and functions of each knife were listed, a lesson was developed following Clark's lesson format. Line drawings of the various knives were prepared and instructional booklets were reproduced.

The same graphics procedures were followed in developing the cutlery materials that were followed in developing the materials for the common fasteners and the plumbing symbols. A summary of the content for the cutlery materials is given in Figure 7.

Scripts for the Lecture

A script was developed for each of the concepts to be presented. The scripts are included in Appendix B. In the development of the scripts, it was necessary to keep the language as simple and meaningful as possible to the learner, but at the same time maintain a reasonable degree of technical integrity as most tradesmen have very specific terms for their trades and expect trainees (and consumers for that matter) to use the same technical terminology. (Those who have tried to purchase replacement items for mechanical devices have undoubtedly already found this to be true.) The scripts which were developed (see Appendix B) conformed to Clark's lesson format and included the standard terminology used in industry.

Irrespective of the number of technical words appearing in the scripts, an effort was made to keep the overall level of communication comprehensible for the students involved in the study. To monitor the level of communication for the various scripts, the Easy Listening Formula

FIGURE 7

Summary of Content for the Instructional Materials to Teach Knife Functions

	Total Number of Instructional Frames	Total Number of Positive Instances Presented	Total Number of Critical Attributes Taught	Total Number of Nonexamples and Discriminators Presented	Total Number of Formative Test Items	Total Number of Summative Test Items
Utility Knife	9	8	5	5	9	7
Hunting Knife	8	7	4	4	9	6
Fish Knife	7	6	3	4	9	6
Butcher Knife	7	6	2	6	9	6
Paring Knife	7	6	1	4	9	7
Pruning Knife	6	5	1	4	8	7
Meat Cleaver	7	6	2	4	9	6
Grand Total	51	44	18	31	62	45

(ELF) developed by Irving E. Fang (1966) at the University of California was used. The ELF was designed to measure the average sentence difficulty of television newscasts.

The correlation between the ELF and the Flesch Reading Ease Formula was +.96 for 36 television scripts and 36 newspaper samples. Based on an analysis of 152,890 words of text, Fang found that the ELF scores of the most highly rated television news programs averaged around 12. By comparison, an analysis of the various scripts used in this research project averaged 4.15.

Development of Dependent Measures

Three dependent measures were developed or adapted for use in this research effort.

Adaptation of the Test Instrument (Common Fasteners): The pretests and posttests used in this study were adapted from instruments developed by Hull (1976). Hull took steps to ensure both face validity and content validity. Reliability of the test was determined by calculating a Kuder-Richardson (K-R) 20 reliability coefficient for some 15 administrators of the test in pilot studies and actual experiments. The reliability coefficients for these administrations ranged from .715 to .944. The test was designed to measure:

"(1) Overgeneralization--all positive instances plus some noninstances are classified as concept instances.

(2) Undergeneralization--not all of the positive instances and some noninstances are classified as concept instances.

(3) Misconception--noninstances only are classified as positive concept instances.

> (4) Concept formation--positive instances only are identified as examples of a concept."

To assess the extent to which students had formed the designated concept, the pretest and posttest instruments required students to correctly select positive instances of the designated concept from an array of related concepts and non-instances which differed from the designated concept by only one attribute. For further discussion of Hull's instrument, see Hull (1976), Barry (1976), and Goodwin (1977). Although Hull's original instrument was used in this study, it had to be modified for the purpose of using a multiple matrix sampling technique. Since Hull's original instrument consisted of 42 items, three more test items were added. Next the test items were stratified by content area. That is, the items testing a single concept, flat head wood screw for example, were grouped together. Then within the content groups, items were structued by difficulty level. Next, items were randomly assigned without replacement to three groups. These procedures were repeated for both the pretest and posttest.

The results of these reconstruction procedures were three tests of equivalent length (15 items each), equivalent content (three questions for each of five concepts), and approximately equal difficulty level.

Adaptation of Additional Test Instruments: Several of the sub-studies in this research project presented concepts other than common fasteners as the lesson. One series of sub-studies used common plumbing valves as the concept to be learned; others used common cutlery. The pretests and posttests for the plumbing valves were adapted in the same manner as the pre- and posttests for the common fasteners. The original 45 items were stratified by group and randomly assigned to subtests in such a manner that the three subtests were equivalent in length, content (concepts covered), and difficulty.

The pretests and posttests for the common cutlery concepts were developed from the onset with a multiple matrix sampling technique in mind. An item pool of 49 test questions was constructed. The pool was then stratified into seven groups corresponding to the seven concepts included in the lesson. Each group contained seven items. Three subtests were then constructed by randomly assigning the concepts to three subtests. Each subtest tested each concept twice and one concept three times. The three subtests, each containing 15 items, were then administered in such a way that each experimental group received all 45 test items, with five persons in a particular experimental group receiving each of the subtests.

Test reliability: Test reliability for each of the pretest and posttest sub-tests used in this study was determined by a Kuder-Richardson (K-R) 21 analysis. Using matrix scores in the Kuder-Richardson formula, test reliability levels were obtained for each sub-test form as indicated in Table 1.

One limitation of this formula is that it underestimates the reliability coefficient of a test when the items vary significantly in difficulty. Ideally, for the Kuder-Richardson 21, items should range in difficulty somewhat between 30% and 70%. A significant number of

TABLE 1

Kuder-Richardson 21 Reliability Levels for the Three Sub-tests Used in the Study

Subtest	Pretest KR-21	Posttest KR-21
Subtest 1	.85	.71
Subtest 2	.90	.56
Subtest 3	.95	.75

The formula for the Kuder-Richardson 21 is:

$$r = \frac{K}{K - 1}\left[1 - \frac{M(K - M)}{K\sigma^2}\right]$$

In this formula:

- K - represents the number of items in the test
- M - represents the mean test score
- σ^2 - represents the variance of the scores on the test.

the items in the subtests used in this study exceeded the 70% difficulty level (see Table 2). Hence, the reliability coefficients reported in Table 2 can be expected to be very conservative.

TABLE 2

Difficulty Level for Items on the Three Posttest Subtests Used in the Study

Posttest Item	Form 2A	Form 2B	Form 2C
1	.75	.75	.50
2	.60	.90	.55
3	.90	.85	.75
4	.85	.95	.70
5	.90	.60	.90
6	.75	.80	.50
7	.75	.90	.80
8	.80	.85	.45
9	.50	.70	.80
10	.40	.70	.85
11	.65	.75	.65
12	.65	.90	.70
13	.65	.80	.95
14	.95	.80	.75
15	.75	.90	.85

Preparation of the Data

As soon as the pretests and posttests for each study had been administered, the data was transferred to magnetic disk storage for future computer assisted analysis. The information on each booklet was coded and then entered on disk by means of the Milton-Wylbur on-line access system. This was done by an individual with several years experience in data entry. The stored data was then out put on a hard copy printer and triple checked. It was checked twice by the data-entry person and then checked a third time by another data-entry person. All computer operations were performed at the Texas A&M University Data Processing Center on the Amdahl 470/6 computer.

The data was analyzed with the aid of the Statistical Analysis System software package which is suitable for the type of data gathered and the types of analyses desired.

Computer Programs Used in the Analysis of Data: Analysis of the data for this study was accomplished with a series of programs out of the Statistical Analysis System (SAS). The system was developed in the late 1960's at North Carolina State University. A User's Guide to SAS.76 by Barr, Goodnight, Sall, and Helwig (1976) served as the primary reference manual in using the SAS pre-programmed computer operations. The Texas A&M University Data Processing Center supports the SAS system and provided the hardward necessary to use the SAS system, including the Amdahl 470/6 computer. The following SAS programs were used in the calculation of various statistical procedures:

GLM - The general linear models procedure incorporates the principle of least squares to fit a fixed-effects linear model to virtually any type of data. This procedure was used for computing analysis of variance and analysis of covariance.

CORR - The procedure computers univariate descriptive statistics and correlation coefficients between variables. For this study, the Pearson product-moment correlation coefficient was computed for the data requiring the CORR procedure.

DUNCAN - This procedure was used to compute Duncan's multiple range test to identify significant differences between group means when the overall hypothesis of no significant differences among several means had been rejected.

Reporting of R^2 Values

For each analysis of variance or analysis of covariance included in this, an R^2 value is given. The reporting of R^2 values may not be a common practice among persons likely to review this research. For this reason, a brief description of R^2 values is given in the following paragraphs.

R^2 values: In an analysis of covariance, an F ratio does not tell whether the effects are large or small. This information is provided by an examination of variance components to measure the strength of the association between the independent and dependent variables. This can be cone by calculating an r^2 value.

For each of the analyses of covariance, an R-squared value was calculated. The purpose for calculating the r^2 value was to determine the practical significance of the effects associated with the statistical model for the analysis of covariance.

In interpreting the practical significance of behavior science data in terms of correlations coefficients (r), Cohen suggests the following guidelines. Small effects require an r value equal to .10; medium effects require an r value equal to .30; and large effects require an r value equal to .50. Cohen's position implies that a medium effect (in terms of the strength of the analysis of covariance model) would be encountered when an r^2 value of at least .09 is obtained. An r^2 value of this magnitude would signify that at least 9% of the variance associated with the analysis of covariance model is attributable to the independent variable or treatments. A large effect would be enountered when the r^2 value is .25 or greater, meaning that 25% of the variance associated with the model is attributable to the independent variable.

The variances associated with the model (referred to above) are attributable to the combination of the method effects, group effects, and interaction effects as measured by the posttest scores with the pretest scores serving as the covariate.[1]

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[1] Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, Academic Press, New York, 1979.

Matrix Sampling

To shorten the time required to administer pretest and posttest measures, a multiple matrix sampling technique was used in this study.

Historical Background: Multiple matrix sampling has been in use for more than two decades. One of the first discussions of the technique to appear in the literature was authored by Hooke (1956) who explained the statistical basis for matrix sampling. In the early literature, the technique was given several different names: bisamples, interpenetrating subsamples, balanced incomplete block designs, and Type 12 sampling. Until recently, little mention was made of multiple matrix sampling in conjunction with the social sciences or education. For the past few years, however, the application of multiple matrix sampling has increased significantly in educational and social science research.

The increased use of multiple matrix sampling may be attributed in part to the development of computer programs which can readily calculate the complex statistical procedures associated with the technique. Much of the credit for developing computer programs and statistical procedures for the use of the multiple matrix sampling procedures in educational research must be given to Shoemaker. Shoemaker's text, Principles and Procedures of Multiple Matrix Sampling, presents a thorough discussion of the technique in the context of educational and social science research. The computer program used to calculate the matrix means and standard deviations in this study was designed by Shoemaker.

Explanation of Multiple Matrix Sampling: The application of multiple matrix sampling begins with the selection of a sample which represents a given population. In this study, the population consisted of the students in a large suburban high school. (Characteristics of the high school population are given elsewhere in this report.) A sample was selected of sufficient size to assign 15 students each to four experimental cells. The entire sample consisted of 60 pupils. The dependent measure for the study consisted of 45 pretest items and 45 posttest items. However, the entire universe of 45 items was not given to each student. Rather, the 45 items were randomly subdivided into three sets of 15 items. A multiple matrix sampling statistical technique was then used to calculate how the subjects in a given experimental cell would have performed had they taken the entire 45 item pretest and posttest rather than the 15 item pretest and posttest. In other words, multiple matrix sampling was used to calculate an "assumed" group mean on 45 items even though no particular subject answered more than 15 test items. However, all three subtests were given to at least some of the subjects in each of the four experimental cells. This means that taken as a whole, each experimental cell of 15 subjects answered all 45 items of the pretest and all 45 items of the posttest. This will be explained further in the following theoretical discussion of multiple matrix sampling.

Multiple Matrix Sampling is a procedure whereby both a given population and a test item pool are sampled, hence the use of the term "multiple". In constructing a subtest for matrix sampling purposes, a pool of test items is generated. These items are then classified as to their difficulty. To determine item difficulty the entire pool of test items is administered (usually as a pilot test) to a group of subjects, preferably a group with similar characteristics (such as intellectual capacity, grade level, etc.) to the experimental group. From the pilot test results, an item difficulty analysis can be calculated. The test items are then stratified by difficulty level and assigned on a randomized basis to a series of subtests. The assignment to subtests is completely randomized without replacement.

Sometimes the pool of items will need to be stratified topically. For example, subjects in this study were taught five concepts: (1) hexagon head bolt, (2) round head wood screw, (3) flat head wood screw, (4) hexagon socket set screw, and (5) fillister head cap screw. In the pool of 45 test items, each of the five concepts was covered nine times. In developing the subtests, a blocking procedure was used so that each subtest would contain an equal number of test items for each of the five screws and bolts. Following these procedures, the subtests that were developed were approximately equivalent in difficulty level, item content, and length.

To form the test groups, subjects are randomly selected from the population. If a blocking procedure is used to assign subjects to experimental groups on a randomized basis with blocking, the same stratification procedure can be used in assigned subjects to subtests. In this study, the original pool of test items was divided into three subtests using stratified random sampling and the 60 subjects in the experimental sample were divided into four approximately equivalent experimental groups assigned to three subtests using a stratified random sampling procedure. The resulting multiple matrix sampling procedure is graphically depicted in Figure 11.

FIGURE 11

Multiple Matrix Sampling Diagram

	Subtest 1 (15 items)	Subgroup A (20 examinees)	
45 Item Pool	Subtest 2 (15 items)	Subgroup B (20 examinees)	60 Subjects in Experiment
	Subtest 3 (15 items)	Subgroup C (20 examinees)	

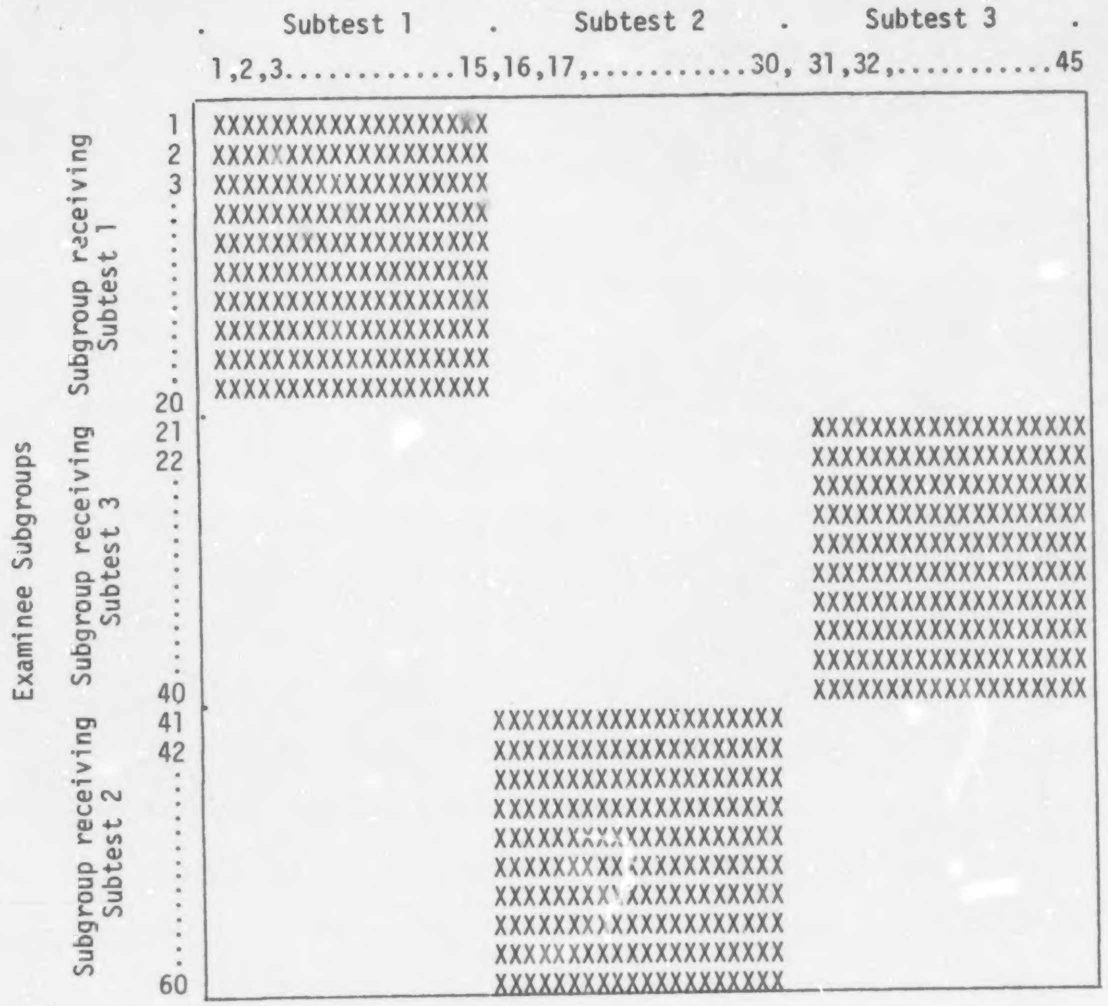
An alternative way to view the multiple matrix sampling procedure is graphically portrayed in Figure 12. In mathematical terms, Figure 12 shows a set of elements arranged as matrices in a series of rows and columns. There are rows of examinees and columns of test items. There are three matrices. The first matrix consists of examinees 1-20 being administered items 1-15; the second matrix consists of examinees 21-40 being administered items 31-45; the third matrix consists of examinees 40-60 being administered items 16-30. The total procedure is multiple matrix sampling, a procedure which enables the research to assume with a high level of confidence the mean performance scores that would be attained by experimental groups if all subjects took tha entire test of 45 items. Because not all subjects respond to all test items, multiple matrix sampling can only be used to measure and compare group performance. It cannot be used to compare individual performances.

FIGURE 12

Multiple Matrix Sampling Depicted as
a Series of Mathematical Matrices

45 TEST ITEMS

Randomly Grouped by Size, Content, and Difficulty to Form
Three Approximately Equivalent Subtests


Subtest 1
Subtest 2
Subtest 3
1,2,3............15,16,17,..........30, 31,32,..........45
1
2
3
20
21
22
40
41
42
60
Examinee Subgroups
Subgroup receiving Subtest 1
Subgroup receiving Subtest 3
Subgroup receiving Subtest 2

Advantages and Disadvantages: A major advantage of multiple matrix sampling lies in the reduction of test length that the procedure makes possible. Less time is required to administer the subtests to individual students, thereby reducing interference with normal school activities when students are involved. Subjects are less fatigued, hence less apt to give up and start responding by guessing. The procedure is especially well suited for the assessment of large groups. It cuts the costs time involved in determining the performance (or assumed performance) of large populations across a large pool of test items. The procedure may also improve group assessment in that the number of item domains that can be tested across a particular experimental group may be larger than would be possible if every students responded to every test item.

Like any statistical procedure, multiple matrix sampling has some disadvantages which must be considered when considering its use. It can be cumbersome to administer without very careful organization of the subtests. The statistical calculations associated with matrix sampling are unusually complex, one requiring computer assistance. The procedure can only be used to determine group performance; comparisons of individual performances within or across experimental cells would be invalid. Another significant disadvantage rests in the fact that the procedure calls for subgroups of at least four or more subjects. When subgroups number fewer than four, the computer program which calculates the input data will not accurately compute variances, standard errors of measurement, and other calculations.

Clearly, before multiple matrix sampling is used, its advantages must be weighed to determine whether they outweigh its limitations.

Reasons for the Use of Matrix Sampling in This Study: Previous research by Hull (1976), Barry (1976) and Goodwin (1977) using a 45 item pretest and posttest pointed out a need to reduce testing time. As in this study, the subjects involved in the research were enrolled in public schools and followed structured curricula, a fact that meant the usual daily schedule had to be interrupted in order to participate in the study. The EMR students involved in Hull and Barry's research required up to 25 minutes to take the pretest and 25 mintes to take the posttest. Attention began to waver after 10 to 15 minutes. Many of the questions (which of these screws is the hexagon head bolt?) began to appear very redundant by the time the same concept had been tested nine times. The posttest was given immediately following instruction in each of the studies mentioned, meaning that altogether the students were required to concentrate on the lesson (25 minutes) and the test (25 minutes) for close to an hour. Because of the novelty of the experimental conditions, many students managed to at least appear to be concentrating on the learning task and the posttest which followed it. However, it was very clear that a shortened posttest would be highly desirable, because it caused less fatigue, allowed for greater concentration on the part of the entire experimental group, and it could be scheduled to start and end in a normal 50 minute period (most high schools schedule 50 minute periods).

School administrators were more receptive to the idea of conducting a study that required no more than an hour of a student's time over a two day period than one which called for 1 1/2 or more of time. By having the test administered to several small subgroups, scheduling room space for the testing did not present a problem. These benefits were considered of greater importance in the study than the limitations encountered in the use of the technique.

With the decision to use multiple matrix sampling came certain essential preparations. The original tests designed by Hull (1976) had to be redesigned following the sampling and stratifying procedures discussed previously in this section of the report. Also, the computer program designed by Shoemaker had to be adapted for use of the Amdahl 470/6 computer at Texas A&M University's Data Processing Center.

CHAPTER 4

RESULTS OF THE RESEARCH

This chapter reports the outcomes of eight substudies which were conducted as part of the overall research effort. For each substudy, there is a brief description of the experimental design followed, a description of the data, and a brief analysis of the outcomes, including a statement of conclusions where appropriate. The overall implications drawn from the research are discussed in Chapter 5. Chapter 5 is available upon request from the researchers as a separate publication, a mini-report.

Substudy I examined the influenced of group size and presentation mode (lecture versus programmed booklet) on concept formation.

Substudy II investigated a series of factors to determine the extent to which they influence the acquisition of a proxiological concept (a concept requiring motor performances).

Substudy III reports the outcomes of a search for educational factors which correlate significantly with employer ratings of on-the-job performance.

Substudy IV investigated the influence of advanced organizers on concept formation.

Substudy V compared the performance of three classifications of students on a concept formation task.

Substudy VI compared the effectiveness of instructional materials which employ concept teaching strategies with materials which do not incorporate the use of such strategies.

Substudy VII consisted of an examination of the influence of verbal cues on concept formation across two classifications of students: mentally retarded students and learning disabled students.

Substudy VIII compared the effectiveness of two instructional paradigms for teaching vocational concepts to handicapped students: a paired-associate paradigm.

All of the studies taken together served as the basis for drawing certain conclusions about teaching vocational concepts (both cognitive concepts and action concepts) to handicapped students. These conclusions are given in the final chapter.

SUBSTUDY I

The Influence of Group Size and Presentation Mode on Concept Formation

The purpose of this substudy was to examine selected variables which influence the acquisition of pre-vocational and vocational concepts by students with learning handicaps. To achieve this purpose, seven null hypotheses were stated, each of which tested a particular research supposition.

Research Design and Assignment of Subjects to Experimental Cells

The research design for this study consisted of a randomized block factorial design. The factorial design permitted an investigation of the combined effects of two presentation modes and two instructional arrangements. The statistical model for the randomized block factorial design is:

$$X_{ijm} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \pi_m + \Sigma_{ijm}$$

Where:

μ - represents the grand mean

α_i - represents the presentation mode

β_j - represents the instructional arrangement

$\alpha\beta_{ij}$ - represents the interaction between presentation mode and instructional arrangement

π_m - represents the blocking effect

Σ_{ijm} - represents experimental error

The blocking factor used for the research was I.Q. I.Q. scores were obtained for each subject whose parents had given written consent for participation of their child in the study as well as consent for release of confidential information (i.e., I.Q., achievement test results, and so forth). Each I.Q. score was then assigned a code number so that it could be traced to a student's name. Next the I.Q.'s were rank ordered from the highest to the lowest, resulting in a high of 88, in a low of 45, and a median of 69.

Once rank ordered, the I.Q. scores were subdivided by fours, because students were to be assigned to four experimental cells, corresponding to two presentation modes and two instructional arrangements. The four highest I.Q. scores constituted the first set of scores to be assigned to the experimental cells, and of these each I.Q. score was randomly assigned to one of the four cells. This was done by writing the numbers 1 through 4 on wooden blocks and by randomly assigning a number 1-4 to each of the experimental cells. The blocks were subsequently placed in a box from which they were randomly drawn without replacement. The number showing on the block determined the cell where the highest I.Q. score remaining would be assigned. Each cell was numbered either 1, 2, 3, or 4.

Given the set of four I.Q. scores: 78,76, 76, and 72, the highest score, 78, would be assigned to the cell which had an assigned number corresponding to the first number randomly drawn from the box. If the number 3 had been drawn first from the box, then the I.Q. 78 (and the child who generated that I.Q.) was assigned to the third cell which, for example, was the group instructional arrangement and the lecture with overhead transparency mode of presentation.

Using this stratified random assignment procedure resulted in four groups that were approximately equivalent in terms of I.Q. The mean I.Q.'s for the four groups were: 69.06, 67.06, 70.8, and 66.46.

A comparison of the four groups along several dimensions can be made by consulting Tables 3, 4, 5, and 6.

Comparison of the Experimental Groups

A comparison of mean I.Q. levels across the four groups has already been discussed. The groups were comparable in the mean level of reading achievement: 3.43, 3.23, 3.26, and 3.05. Math achievement levels were also comparable: 3.56, 2.84, 3.61 and 3.6. Assignment by I.Q. scores meant that the groups were not necessarily balanced in terms of either race or sex. As it turned out, the number of students of caucasian ancestry for the groups were 4, 8, 4, and 5. The remainder of the participants were black. In terms of sex, females constituted a minority with 3, 3, 5, and 3, females assigned to the groups. Altogether, the groups were relatively equivalent along several dimensions.

Hypothesis One

Lecture With Overhead Transparencies Versus Tape With Programmed Booklet

The first null hypothesis predicted that there would be no significant difference between the performance of EMR/LD students assigned to a lecture with overhead transparencies mode of presentation versus an equivalent group of students assigned to an audio transcription (cassette tape) plus a programmed booklet mode of presentation in a vocational

Table 3

Characteristics of Subjects in Lecture with Overhead Transparency Treatment (Individualized Instructional Arrangement)

Student Identifier	IQ	Sex	Race	Grade Level in Reading	Grade Level in Math
I-LOT-A	75	M	B	4.7	4.2
I-LOT-B	73	M	B	3.1	3.2
I-LOT-C	50	F	B	3.5	3.6
I-LOT-D	68	M	B	2.9	3.9
I-LOT-E	80	M	C	3.0	2.6
I-LOT-F	70	F	B	4.2	2.9
I-LOT-G	68	M	B	3.1	4.2
I-LOT-H	75	M	C	4.1	2.3
I-LOT-I	69	M	B	3.1	4.6
I-LOT-J	69	F	C	3.4	3.8
I-LOT-K	69	M	B	2.6	3.0
I-LOT-L	68	M	C	2.8	3.2
I-LOT-M	59	M	B	2.6	3.6
I-LOT-N	68	M	B	5.4	5.2
I-LOT-O	75	M	B	2.9	3.1
Mean $\bar{x}$ =	69.0$\bar{6}$			3.43	3.56
SD =	7.13			0.819	0.779
Number =	15			15	15

Table 4

Characteristics of Subjects in Tape With Programmed Booklet Mode of Presentation (Individualized Instructional Arrangement)

Student Identifier	IQ	Sex	Race	Grade Level in Reading	Grade Level in Math
I-TPB-A	72	M	B	3.9	2.3
I-TPB-B	60	M	C	2.8	3.0
I-TPB-C	65	M	B	3.4	2.6
I-TPB-D	60	M	B	4.7	2.9
I-TPB-E	68	M	C	5.4	3.1
I-TPB-F	50	M	C	1.7	2.6
I-TPB-G	77	F	B	2.6	2.9
I-TPB-H	72	M	C	3.7	3.3
I-TPB-I	72	M	C	3.6	3.5
I-TPB-J	72	M	B	2.6	2.3
I-TPB-K	68	F	C	3.2	3.4
I-TPB-L	68	M	C	3.7	3.9
I-TPB-M	60	M	C	2.4	2.4
I-TPB-N	72	F	B	2.3	2.2
I-TPB-O	70	M	B	2.5	2.2
Mean $\bar{x}$ =	$67.0\bar{6}$			$3.2\bar{3}$	2.84
SD =	6.95			0.976	0.527
Number =	15			15	15

Table 5

Characteristics of Subjects in Lecture with Overhead Transparency Mode of Presentation (Group Instructional Arrangement)

Student Identifier	IQ	Sex	Race	Grade Level in Reading	Grade Level in Math
G-LOT-A	55	M	B	2.6	3.4
G-LOT-B	62	F	C	2.9	3.1
G-LOT-C	70	M	C	2.7	2.5
G-LOT-D	70	M	B	2.1	2.6
G-LOT-E	71	F	B	2.9	3.0
G-LOT-F	68	M	B	4.7	4.2
G-LOT-G	45	M	B	4.7	4.2
G-LOT-H	60	M	B	3.1	3.2
G-LOT-I	70	M	B	2.7	3.4
G-LOT-J	64	M	C	3.6	3.9
G-LOT-K	71	F	B	3.2	4.2
G-LOT-L	80	M	B	4.2	3.6
G-LOT-M	76	M	B	4.0	6.4
G-LOT-N	65	F	B	3.2	4.0
G-LOT-O	70	F	C	2.4	2.4
Mean $\bar{x}$ =	$66.4\bar{6}$			$3.2\bar{6}$	3.61
SD =	8.58			0.808	0.988
Number =	15			15	15

Table 6

Characteristics of Subjects in Tape Plus Programmed Booklet Mode of Presentation (Group Instructional Arrangement)

Student Identifier	IQ	Sex	Race	Grade Level in Reading	Grade Level in Math
G-TPB-A	60	M	B	1.7	3.6
G-TPB-B	60	M	B	2.8	3.9
G-TPB-C	72	F	B	2.7	5.0
G-TPB-D	80	M	B	2.7	3.4
G-TPB-E	72	F	B	3.5	3.9
G-TPB-F	60	F	B	2.9	3.9
G-TPB-G	71	M	B	3.9	3.6
G-TPB-H	65	M	C	3.3	4.1
G-TPB-I	60	M	B	3.5	3.2
G-TPB-J	72	M	C	1.7	2.6
G-TPB-K	88	M	C	5.2	3.8
G-TPB-L	72	M	C	3.2	3.4
G-TPB-M	69	M	B	2.3	3.2
G-TPB-N	88	M	C	3.5	3.8
G-TPB-O	73	M	B	2.8	3.6
Mean $\bar{x}$ =	70.8			3.05	$3.\bar{6}$
SD =	9.22			0.872	0.527
Number =	15			15	15

concept learning task. In Table 7, a presentation of the pretest and posttest raw scores for each subject in the experiment is given together with a breakdown of the means and standard deviations for each experimental condition.

Table 7

Raw Scores Across Two Presentation Modes

Lecture with Overhead Transparencies		Tape with Programmed Booklet	
Pretest	Posttest	Pretest	Posttest
2	14	7	10
10	12	4	13
6	12	5	11
7	15	6	13
6	14	12	15
9	11	6	10
4	12	8	12
4	12	8	12
4	15	5	12
4	8	6	14
4	12	2	12
5	15	8	10
5	12	10	11
5	13	4	9
3	8	8	8
6	6	2	4
3	12	7	12
5	13	7	10
10	14	5	10
10	14	7	10
4	10	3	10
5	8	10	9
8	11	5	11
4	12	2	9
6	11	6	11
6	11	11	11
6	12	11	15
11	13	5	7
7	9	11	14
4	10	4	12
N = 30 $\bar{x}$ = 5.766 SD = 2.329	N = 30 $\bar{x}$ = 11.7 SD = 2.261	N = 30 $\bar{x}$ = 6.5 SD = 2.813	N = 30 $\bar{x}$ = 10.9 SD = 2.324

Table 7 gives the raw scores for the pretest and posttest across the two presentation modes. The raw score group means represent how students in the study performed across three subtests each of which contained 15 items randomly selected without replacement from a total pool of 45 items.

Table 8 presents the pretest and posttest scores derived from the matrix data. The matrix scores indicated the assumed performance levels that groups would have received had they been tested with the entire pool of 45 pretest and 45 posttest items.

Table 7 shows that there were 30 subjects assigned to each presentation mode. The means and standard deviations for the two treatment groups are as follows: the pretest mean for the lecture with overhead transparency group was 5.77 with a standard deviation of 2.33. The posttest mean for this group was 11.7 with a standard deviation of 2.261.

The pretest mean for the group given the tape with programmed booklet treatment was 10.9 with a standard deviation of 2.32. The posttest mean for this group was 10.90 with a standard deviation of 2.32.

The two present an equivalent set of scores in terms of matrix data. The matrix scores represent levels that the treatment groups would have received had they been tested with the entire pool of 45 pretest items and 45 posttest items. Matrix data is presented in Table 8.

In matrix presentations, the standard error of the mean is also given to show the range of assumed variability within each cell.

The matrix score means, standard deviations, and standard error of the mean for the lecture with overhead transparency treatment group were 17.3, 6.99, and 1.97 respectively. Posttest means for this group was

Table 8

Matrix Score Across Two Presentation Modes

Lecture with Transparencies		Tape with Programmed Booklet	
Pretest	Posttest	Pretest	Posttest
6	42	21	30
30	36	12	39
18	36	15	33
21	45	18	39
18	42	36	45
27	33	18	30
12	36	24	36
12	36	24	36
12	45	15	36
12	24	18	42
12	36	6	36
15	45	24	30
15	36	30	33
15	39	12	27
9	24	24	24
18	18	6	12
9	36	21	36
15	39	21	30
30	42	15	30
30	42	21	30
12	30	9	30
15	24	30	27
24	33	15	33
12	36	6	27
18	33	18	33
18	33	33	33
18	36	33	45
33	39	15	27
21	27	33	42
12	30	12	36
N = 30	N = 30	N = 30	N = 30
$\bar{x}$ = 17.3	$\bar{x}$ = 35.1	$\bar{x}$ = 19.5	$\bar{x}$ = 32.9
SD = 6.99	SD = 6.784	SD = 8.439	SD = 6.707
SE = 1.97	SE = 1.48	SE = 1.83	SE = 1.56

35.1; the standard deviation was 6.78; and the standard error of the mean was 1.98.

The matrix pretest mean for the tape with programmed booklet mode of presentation was 19.5 with a standard deviation of 8.44 and a standard error of the mean of 1.83. The posttest mean for this group was 32.9, with a standard deviation of 6.71, and a standard error of the mean of 1.56.

To determine whether the first null hypothesis would be rejected or accepted, an analysis of covariance was performed using the pretest scores as the concomitant variable or covariate. The outcome of the analysis of covariance for the raw scores is presented in Table 9. A significant F value ($F_{1,55} = 5.33$) was attained with an α level of .05; therefore, the null hypothesis ($\mu_1 = \mu_2$) was rejected.

An analysis of covariance was also performed using the matrix data. The outcome of this analysis is presented in Table 10. As shown in

Table 9

2 x 2 Factorial Analysis of Covariance Across Two Presentations Methods And Two Instructional Arrangements Using Raw Score Means

Source of Variance	DF	MS	F	P
Total	60			
Group	1	31.542	6.40	0.0143
Method	1	26.266	5.33	0.0247
GRP/METH	1	0.793	0.16	0.6898
Covariate	1	55.272	11.21	0.0015
Error	56	4.930		

Table 10

2 x 2 Factorial Analysis of Covariance Across Two Presentation Methods and Two Instructional Arrangements Using Matrix Scores

Source of Variance	DF	MS	F	P
Total	60			
Group	1	283.874	6.40	0.0143
Method	1	236.395	5.33	0.0247
GRP/METH	1	7.134	0.16	0.6898
Covariate	1	407.445	11.21	0.0015
Error	56	44.368		

Table 10, the F values ($F_{1,55} = 5.33$) for the treatment condition were virtually identical to the F values attained when the raw scores were analyzed. Again, a difference at the 0.025 level of significance was observed between the assumed treatment means for the two treatments, a difference favoring the tape with programmed booklet mode of presentation.

The null hypothesis ($\mu_1 = \mu_2$) that there could be no significant difference between the two treatment conditions with EMR/LD students was rejected based on the analysis of covariance.

Hypothesis Two

Group Instruction Versus Individual Instruction

Null hypothesis two ($\mu_3 = \mu_4$) stated there would be no significant difference between the performance levels of who received individualized instruction versus students who received group instruction. This hypothesis was tested using data that appears in Tables 11 and 12.

Table 11

Raw Score Means and Standard Deviations Across Two Instructional Arrangements

Individual Instruction		Group Instruction	
Pretest	Posttest	Pretest	Posttest
2	14	6	6
10	12	3	12
6	12	5	13
7	15	10	14
6	14	10	14
9	11	4	10
4	12	5	8
4	12	8	11
4	15	4	12
4	8	6	11
4	12	6	11
5	15	6	12
5	12	11	13
5	13	7	9
3	8	4	10
7	10	2	4
4	13	7	12
5	11	7	10
6	13	5	10
12	15	7	10
6	10	3	10
8	12	10	9
8	12	5	11
5	12	2	9
6	14	6	11
2	12	11	11
8	10	11	15
10	11	5	7
4	9	11	14
8	8	4	12
N = 30 $\bar{x}$ = 5.9 SD = 2.41	N = 30 $\bar{x}$ = 11.9 SD = 2.056	N = 30 $\bar{x}$ = 6.366 SD = 2.772	N = 30 $\bar{x}$ = 10.7 SD = 2.423

The pretest raw score mean for the individualized instruction arrangement was 5.9 with a standard deviation of 2.41. The posttest mean was 11.9 with a standard deviation of 2.66.

Table 12

Matrix Means and Standard Deviations
Across Two Instructional Arrangements

Individual Instruction		Group Instruction	
Pretest	Posttest	Pretest	Posttest
6	42	18	18
30	36	9	36
18	36	15	39
21	45	30	42
18	42	30	42
27	33	12	30
12	36	15	24
12	36	24	33
12	45	12	36
12	24	18	33
12	36	18	33
15	45	18	36
15	36	33	39
15	39	21	27
9	24	12	30
21	30	6	12
12	39	21	36
15	33	21	30
18	39	15	30
36	45	21	30
18	30	9	30
24	36	30	27
24	36	15	33
15	36	6	27
18	42	18	33
6	36	33	33
24	30	33	45
30	33	15	27
12	27	33	42
24	24	12	36
N = 30	N = 30	N = 30	N = 30
$\bar{x}$ = 17.7	$\bar{x}$ = 35.7	$\bar{x}$ = 19.1	$\bar{x}$ = 32.3
SD = 7.235	SD = 6.170	SD = 8.318	SD = 7.032
SE = 1.80	SE = 1.58	SE = 1.98	SE = 2.03

The pretest matrix means for the individualized instruction arrangement was 17.7 with a standard deviation of 7.24, and a standard error of the mean of 1.80. The posttest matrix mean for the same group was 35.7 with a standard deviation of 6.17 and a standard error of the mean of 1.58 (see Table 12).

To test whether the means for the group versus individualized instructional arrangement were significantly different, an analysis of covariance was performed, using the pretest scores as the covariate. The analysis of covariance for the raw scores is shown in Table 9 . A significant F value ($F_{1,55} = 6.46$) with an α level of 0.014 led to the rejection of the null hypothesis.

An analysis of covariance using the matrix scores was also performed, the outcome of which is presented in Table 10. Again, the F value ($F_{1,55} = 6.4$) was significant with an α level of 0.014. The superior group means were associated with the group mode of presentation.

Hypothesis Three

Interaction Between Presentation Mode and Instructional Arrangement

Because the experiment used a factorial design with two presentation modes and two instructional arrangements, it was possible to test for interaction, using a 2 x 2 factorial analysis of covariance statistical technique. The null hypothesis predicted that there would be no significant interaction between the mode of presentation and the instructional arrangement. The data for this hypothesis appears in Tables 9 and 10. An $F_{1,55}$ value of 0.16 was generated yielding a probability of .69, a value much larger than the 0.5 level which had been set as the rejection criterion. Thus, the hypothesis was accepted in its null form.

Hypothesis Four

A Comparison of Two Presentation Modes Within a Group Instructional Arrangement

The fourth hypothesis stated there would be no significant differences between a lecture with overhead transparencies mode of presentation and a tape plus programmed booklet mode of presentation for EMR/LD students within a group instructional arrangement. Means used to test this null hypothesis are derived from Table 13 .

Table 13

Raw Score Means and Standard Deviations for Two Presentation Modes Within a Group Instructional Arrangement

Lecture with OT		Tape/Program Booklet	
Pretest	Posttest	Pretest	Posttest
6	6	2	4
3	12	7	12
5	13	7	10
10	14	5	10
10	14	7	10
4	10	3	10
5	8	10	9
8	11	5	11
4	12	2	9
6	11	6	11
6	11	11	11
6	12	11	15
11	13	5	7
7	9	11	14
4	10	4	12
$\underline{N}$ = 15 $\bar{x}$ = 6.333 SD = 2.439	$\underline{N}$ = 15 $\bar{x}$ = 11.06 SD = 2.218	$\underline{N}$ = 15 $\bar{x}$ = 6.4 SD = 3.157	$\underline{N}$ = 15 $\bar{x}$ = 10.33 SD = 2.636

The raw score pretest mean for the lecture with overhead transparencies mode of presentation was 6.33 with a standard deviation of 2.44. The posttest mean for this group was 11.06, with a standard deviation of 2.22. The pretest mean for the tape with programmed booklet mode of presentation within the group instructional arrangement was 6.4, with a standard deviation of 3.16. The posttest mean for this group was 10.33 with a standard deviation of 2.64.

An analysis of covariance was performed using the pretest as a concomitant variable. This analysis is reported in Table 14. The analysis of covariance yielded an F value ($F_{1,26}$) of 1.66 with a probability of 0.2079. Because this probability level failed to achieve the .05 level of significance, the null hypothesis ($\mu_1 = \mu_2$) was not rejected. Within the group instructional arrangement, the students who were assigned to the lecture with overhead transparency mode of presentation performed in a manner that was not significantly different from the performance levels of students assigned to the tape with programmed booklet mode of presentation.

Table 14

Analysis of Covariance Across Two Presentation
Modes Within a Group Instructional Arrangement

Source of Variance	DF	MS	F	P
Total	29			
Method	1	8.265	1.66	0.2079
Error	27	4.973		

Hypothesis Five

A Comparison of Two Treatment Groups When a Group Instructional Arrangement

The null hypothesis tested for this portion of the research stated that there would be no significant difference between the performance of students assigned to a lecture with overhead transparencies mode of presentation versus a tape plus programmed booklet mode of presentation within an individualized instructional arrangement. The means, which were used to test the validity of this null hypothesis, are given in Table 15 and the analysis of covariance performed to test for significant differences in the means is reported in Table 16.

Table 15

Raw Score Means, and Standard Deviations for Two Presentation Modes Within a Individualized Instruction Arrangement

Lecture W/OUT		Tape/Program Booklet	
Pretest	Posttest	Pretest	Posttest
2	14	7	10
10	12	4	13
6	12	5	11
7	15	6	13
6	14	12	15
9	11	6	10
4	12	8	12
4	12	8	12
4	15	5	12
4	8	6	14
4	12	2	12
5	15	8	10
5	12	10	11
5	13	4	9
3	8	8	8
N = 15	N = 15	N = 15	N = 15
$\bar{x}$ = 5.2	$\bar{x}$ = 12.333	$\bar{x}$ = 6.6	$\bar{x}$ = 11.46
SD = 2.144	SD = 2.1930	SD = 2.529	SD = 1.884

The pretest mean and standard deviation for the lecture with overhead transparencies group within an individualized instruction arrangement were 5.2 and 2.14 respectively. The pretest score for the tape with programmed booklet mode of presentation within the individualized instructional arrangement was 6.6, with a standard deviation of 2.53. The posttest mean was 11.46 with a standard deviation of 1.88.

Table 16

Analysis of Covariance Across Two Presentation Modes Within an Individualized Instructional Arrangement

Source of Variance	DF	MS	F	P
Total	29			
Method	1	11.137	2.56	0.122
Error	27	4.357		

An analysis of covariance was performed to test for differences in performance means. The pretest scores served as the covariate. The outcomes of the analysis are presented in Table 16. The analysis of covariance resulted in a nonsignificant F value ($F_{1,27} = 2.56$). This F value results in a probability of 0.122 which did not reach the .05 level of significance. Accordingly, the hypothesis was accepted in its null form. Although the analysis of covariance across the two modes of presentation across both instructional arrangements indicated that the cell means were significantly different, these differences were not observed when the two modes of presentation were analyzed within the individualized instructional arrangement.

Hypothesis Six

Individual Instruction Versus Group Instruction Within a Programmed Booklet Mode of Presentation

The sixth null hypothesis tested within this study predicted that there would be no significant difference between the performance of students assigned to an individualized instructional arrangement versus students assigned to a group instructional arrangement within a tape plus programmed booklet mode of presentation. The means and standard deviations used to test this hypothesis are given in Table 17.

An analysis of covariance using the pretest as covariate was performed, the outcomes of which are reported in Table 18. It can be seen in Table 18 that the analysis of covariance produced an F value of 2.08 ($F_{1,27} = 2.08$), a value which failed to reach the .05 level of significance ($p < 0.16$). The F value associated with the covariate ($F_{1,27} = 8.66$) was significant at the 0.006 level. This result indicates that the use of the pretest as covariate had an effect on the outcome of the analysis of covariance. The r^2 value for the analysis of covariance was 0.29 meaning that the model accounted for approximately 29% of the total variance associated with the study.

The significant difference between group and individualized instruction across the two presentation modes was not repeated in the tape with programmed booklet mode of presentation.

Table 17

Means and Standard Deviations for Two Instructional Arrangements Within a Tape With Programmed Booklet Mode of Presentation

Individualized Instruction/ Tape with Programmed Booklet		Group Instruction Tape with Programmed Booklet	
Pretest	Posttest	Pretest	Posttest
7	10	2	4
4	13	7	12
5	11	7	10
6	13	5	10
12	15	7	10
6	10	3	10
8	12	10	9
8	12	5	11
5	12	2	9
6	14	6	11
3	12	11	11
8	10	11	15
10	11	5	7
4	9	11	14
8	8	4	12
N = 15 $\bar{x}$ = 6.6 SD = 2.1930	N = 15 $\bar{x}$ = 11.46 SD = 1.884	N = 15 $\bar{x}$ = 6.4 SD = 3.157	N = 15 $\bar{x}$ = 10.33 SD = 2.636

Table 18

Analysis of Covariance for Group Versus Individualized Instructional Arrangements Within a Tape With Programmed Booklet Mode of Presentation

Source of Variance	DF	MS	F	P
Total	29			
Arrangement	1	10.67	2.08	0.16
Covariate	1	44.49	8.66	0.006
Error	27	5.14		

$r^2 = 0.29$

Hypothesis Seven

Individualized Versus Group Instruction In An Overhead Transparencies Mode of Presentation

The final null hypothesis tested in this study predicted that within a lecture with overhead transparency mode of presentation there would be no significant difference between students assigned to a group instructional arrangement versus students assigned to an individualized instructional arrangement. The means and standard deviation used to test this hypothesis are given in Table 19 and in the analysis of covariance which was performed to test for significant differences in the means is reported in Table 20.

The pretest mean for individualized instruction was 5.2 with a standard deviation of 2.14; the pretest mean for group instruction within the lecture with overhead transparencies mode of presentation was 6.33 with a standard deviation of 2.44. The posttest mean for the individualized instructional arrangement was 12.33 with a standard deviation of 2.19. The posttest mean for the group instructional arrangement was 11.06 with a standard deviation of 2.22. An analysis of covariance (see Table 20) yielded an $F_{1,27}$ value of 3.53. This F value was not significant ($p < .07$) because an α rejection level of .05 had been accepted at the outset of the study. The .07 level was very close to significance however. The covariate was not significant ($F_{1,27} = 2.74$; $p < 0.11$).

Analysis of Pretest and Posttest Differences

Differences between pretest and posttest scores across the various treatment conditions and instructional arrangements were tested using an

Table 19

Means and Standard Deviations for Two Instructional Arrangements Within a Lecture with Overhead Transparency Mode of Presentation

Individualized Instruction/LOT		Group Instruction/LOT	
Pretest	Posttest	Pretest	Posttest
2	14	6	6
10	12	3	12
6	12	5	13
7	15	10	14
6	14	10	14
9	11	4	10
4	12	5	8
4	12	8	11
4	15	4	12
4	8	6	11
4	12	6	11
5	15	6	12
5	12	11	13
5	13	7	9
3	8	4	10
N = 15	N = 15	N = 15	N = 15
$\bar{x}$ = 5.2	$\bar{x}$ = 12.333	$\bar{x}$ = 6.333	$\bar{x}$ = 11.06
SD = 2.144	SD = 2.1930	SD = 2.439	SD = 2.218

Table 20

Analysis of Covariance for a Group Versus Individualized Instructional Arrangement Within a Lecture With Overhead Transparency Mode of Presentation

Source of Variance	DF	MS	F	P
Total	29			
Arrangement	1	16.97	3.53	0.07
Covariate	1	13.17	2.74	0.11
Error	27	4.81		

$r^2 = 0.16$

analysis of variance to determine whether significant learning resulted in each of the treatment conditions. This was done by performing a one way analysis of variance between the pretest and posttest scores within each of the four major cells representing type of instructional arrangement and mode of presentation.

The outcomes of the analysis of variance are presented in Table 21 This table shows that there were very significant differences between the pretest and the posttest means associated with the pretest and posttest scores across all cells. All probability levels exceeded the 0.001 level indicating that the instructional materials and procedures used resulted in significant pretest and posttest gains.

Table 21

Analysis of Variance Across Pretest and Posttest
Means for All Experimental Cells

Experimental Condition	F value	P
LOT/GROUP	59.40	0.0000
TPB/GROUP	42.80	0.0001
LOT/Individual	93.24	0.0000
TPB/Individual	42.98	0.0001

Post Hoc Analysis of Differences Between Treatments As a Factor of I.Q. Scores

Because I.Q. scores were used as a blocking factor in the experiment, a Post Hoc analysis was performed to determine whether there were performance differences within each group that could be attributed to I.Q. level.

To perform this analysis, the posttest scores were regrouped as a function of high and low I.Q. groups. This was accomplished by ranking the I.Q. scores for each cell group from the highest to the lowest together with a list of the posttest scores that each individual achieved.

Because there were fifteen total participants in each cell group, the higher I.Q. group was assigned seven I.Q. scores and the lower I.Q. group was assigned either scores.

A T-test was then performed to determine whether the performance of the high and low I.Q. groups were significantly different. The outcomes of this analysis are recorded in Table 22 . In two instances, the pretest means were greater for the high I.Q. group than the posttest means for the lower I.Q. group. The reverse was also true; twice the performance means for the lower I.Q. group exceeded those for the higher I.Q. group. In no instances, however, were the performances means significantly different from each other as indicated by non-significant T values where the α rejection level had been set at .05.

Table 22

Comparison of Cell Performance Across High and Low I.Q. Groups

Treatment Condition	High I.Q.		Low I.Q.		t
	x	SD	x	SD	
Grp/LOT	11.43	3.45	10.00	2.26	.95
Grp/TPB	11.14	1.46	9.63	3.29	-1.14
Ind/LOT	11.86	2.03	12.75	2.37	.87
Ind/TPB	11.00	2.08	11.88	1.72	.38

SUBSTUDY II

The Acquisition of a Praxiological Concept

Vocational instruction often involves the teaching of complex technical operations. This fact has had the effect of limiting enrollment in vocational education to students of average ability or better. Less than 2% of the total enrollment in vocational education is made up of students requiring special educaiton. However, in recent moths there has been considerable pressure put on vocational education to accommodate a higher percentage of disabled persons. (These efforts are described in numerous monographs, journals, and books.)

There are many factors that must be considered when advocating increased enrollments of physically and mentally disabled persons in vocational education. One factor of great importance is excellent teaching.

For a vocational teacher to successfully accommodate a student with learning disabilities, the teacher must either discover or be taught how to successfully induce several types of learning.

Discrimination learning is involved learning to correctly and consistently distinguish among tools, production equipment, and the materials used in various production processes. Discrimination learning is also involved in learning the proper (or desired) size, weight, shape, texture, consistency, color (etc.) of products and product components. Paired associate learning is involved in learning to correctly classify tools, equipment, materials, and technical procedures. Motor learning is involved in learning how to manipulate machines and materials, how to exert the correct amount of pressure, how to bend, turn, shape, stroke, and so forth.

The complexity of vocational education calls for superior teaching. It calls for the application of instructional techniques which have been derived and confirmed from research in psychology, sociology, social psychology, and educational psychology. It calls for the application of promising educational practices.

This purpose of this substudy was to investigate factors which influence the learning of a complex praxiological concept (a concept involving motor performance in addition to cognitive responses). The study was based on a previous study by Clark (1966). Clark developed a lesson for teaching industrial arts students to bend to specification pieces of 1/2 inch electrical metallic tubing. Clark's research found that the performance of students with lower I.Q.'s was inferior to that of students with higher I.Q.'s. For this reason, a study was designed to identify instructional techniques that would enhance the performance of students with below average academic ability (as determined by enrollment in classes for the educable mentally retarded). The lesson format and evaluation procedures replicated Clark's original study.

Lesson Format and Procedures

The lesson presentation for the praxiological task is given in Appendix C. A pictorial analysis is given along with a transcript of the lesson.

The students were shown a practice board, a Benfield Bender, and a three foot length of 1/2 inch electrical metallic tubing. The students were told that the object of the lesson was to learn how to fit the tubing onto the practice board so that it simulated an actual electrical installation in a house or commercial building. To complete the project, the students were required to make three bends: a seven inch stub bend, a 30° offset bend, and a 29 inch back-to-back bend. Each of these tasks was demonstrated to the students. Some students were shown all three steps in succession and were not instructed to practice the bends until the three bends had been demonstrated (a practice often followed in vocational education classes).

Some students were presented with a demonstration of one bend at a time and allowed to covertly rehearse the steps following the presentation. Covert practice consisted of ordering a set of photographs illustrating the various procedures in the proper time (and movement) sequence. These students had ten minutes to order their photographs and receive corrective feedback.

Another group of students were given a demonstration of each bend and then were allowed to overtly practice each bend while receiving corrective feedback.

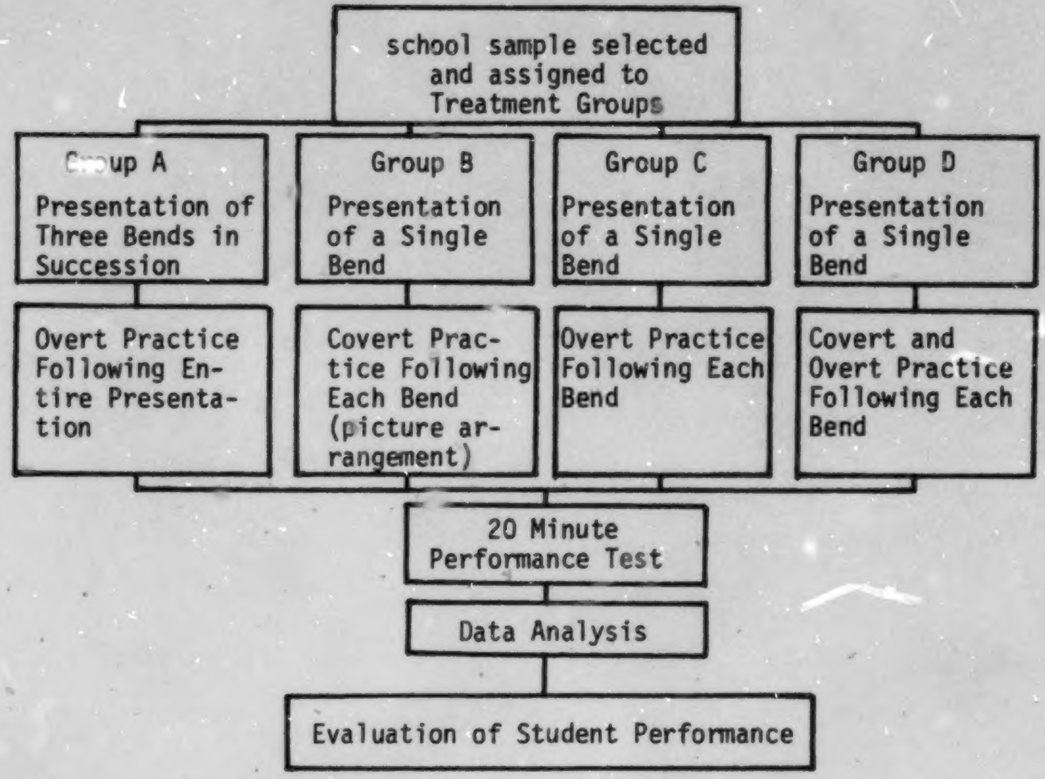
A final group of students were given a demonstration and then allowed to both overtly and covertly practice the bends, again with a ten minute limitation set on the practice period.

These various instructional arrangements and practice arrangements are graphically portrayed in Figure 10.

Following the presentation of the lesson, each group was given a 20 minutes period in which to complete the three bends. A description follows of how the bends were then evaluated.

Figure 10

Praxiological Concept Instructional and Practice Conditions


school sample selected and assigned to Treatment Groups
Group A
Presentation of Three Bends in Succession
Group B
Presentation of a Single Bend
Group C
Presentation of a Single Bend
Group D
Presentation of a Single Bend
Overt Practice Following Entire Presentation
Covert Practice Following Each Bend (picture arrangement)
Overt Practice Following Each Bend
Covert and Overt Practice Following Each Bend
20 Minute Performance Test
Data Analysis
Evaluation of Student Performance

To evaluate the bends made by each student, each operation was evaluated independently. The unit of measure used was a point scale with nine being the most accurate and one being the least accurate, with the score of zero indicating that the operation was not performed within the alloted 20 minutes. The 9-point scale was interpreted as follows:

1. On linear measures for each one-half inch deviation from the standard, one less point value was assigned.
2. On angular measures for every 4° deviation from the standard, one less point was assigned.

If an operation was started, it was not recorded as zero; thus, any operation which was started but did not achieve at least a two rating was assigned a rating of one.

As indicated in Figure 11, eighteen separate operations were evaluated for the four units.

To facilitate the evaluation of each operation, an evaluation board was used by which each measure could be read directly as 9, 8, 7, etc.

Figure 11

Operations by Performance Units

Unit	Operation
Stub bend	Layout Tool placement Angle
First offset	Layout Tool placement Angle Alignment Direction
Second offset	Layout Tool placement Angle Alignment Direction
Back-to-back	Layout Tool placement Angle Alignment Direction

Figure 12 shows the conduit in the position on the evaluation board for evaluating the stub bend and the first bend of the offset.

With the conduit placed squarely against the block, both the layout and angle could be read directly off the board. Proper placement of the bender could be interpreted as the relationship between the layout line and the length of the stub.

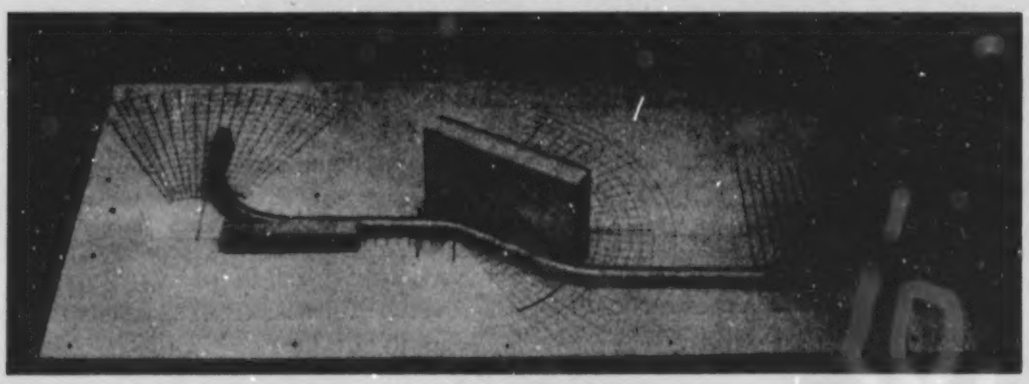
Figure 12

Evaluation Board--Position One

The first bend of the offset was evaluated with the conduit in this same position. The angle was read directly as well as the layout. Tool placement again was evaluated as the relationship of the layout one and the acutal placement of the bend. Alignment was read directly by placing the smaller block to the side of the conduit as in Figure 13. The readings 9, 8, 7, etc. were read directly off the board. One less point was assigned for each 4° out of alignment. Direction was simply a 1 or 9 assignment. If the bend was made in the proper direction it was given the score of 9; if it was in the wrong direction it was given a 1.

Figure 13

Evaluation Board--Position Two



Layout and placement for the second bend of the offset were read from position one. Angle was determined as indicated in Figure 14 -- Position Three.

Figure 14

Evaluation Board--Position Three

From Position Two, the layout, placement, and alignment for the back-to-back bend were determined.

Following this evaluation format, a total of 162 points could be assigned for a totally correct performance. Data was recorded in a format like that illustrated in Figure 15.

Selection of Students

Students for this substudy were selected from a Special Education Cooperative in Central Texas. Ethnic make-up of the groups was about 50% Anglo-American, 35% Black, and 15% Mexican-American. All the students were of high school age and assigned to special education calsses. The majority of the students were mainstreamed for a portion of the school day but segregated for academic instruction.

Figure 15

Praxiological Concept Acquisition

Evaluation Format

Experimental Group______________________________Date_______________

Student Ind. No.__________________________Class No._______________

Home Room________________Home Room Teacher__________________________

Class____

Additional Data____

Praxiological Test

	Stub Bend			First Offset					Second Offset					Back-to-Back					Totals	
	Layout	Placement	Angle	Layout	Placement	Angle	Alignment	Direction	Layout	Placement	Angle	Placement	Direction	Layout	Placement	Angle	Alignment	Direction	Unit	Composite
Practice Score																				
Performance Score																				

Because the experimental task consumed several periods intact classes had to be employed as experimental groups. However, the classes selected were homogeneous in many ways: ethnic composition, age, ability grouping, curriculum, and geographical background. The principal confounding factor that would have been eliminated with a completely randomized assignment strategy was familiarity of the students with one another and group personality (which becomes established after a few weeks of instruction).

Treatment of the Data

The data for the study was recorded as discussed previously and prepared for computer analysis. The descriptive statistics for the study are given in Table 23.

Table 23

Descriptive Statistics for Praxiological Concept Learning Task (Number, Mean, and Standard Deviation)

Treatment		N	$\bar{x}$	SD
Live Presentation:				
1. 3 complete bends. No practice between bends, only at the end.	(A)	6	154.50	75.48
2. Vicarious mental practice after each bend by ordering photo series.	(B)	6	201.17	111.66
3. Overt practice after each bend, interruptions no structure	(C)	9	171.56	78.92
4. Overt practice, good concentration	(D)	8	589.25	330.53
5. With overt and mental practice after each bend and rush for time, crowded room	(E)	10	284.30	160.65

The lowest group means was 154.50 for the group which received the complete lesson before being allowed to practice the task. The highest group mean, 589.25, was recorded for the group which overtly practiced the task following a live demonstration of each bend. Another group which had the same demonstration and same practice conditions had a lower group mean. This group, however, had numerous interruptions and was loosely organized. The instruction was comparable to that received by all groups, but the instructional climate was very poor. The mean performance score for this group was 171.56.

The group which was instructed to both overtly and covertly practice the bends gave the appearance of being over instructed and rushed. Practicing the bends both overtly and covertly in a limited amount of time resulted in a fair amount of confusion. The mean score for this group was 284.3.

The group which was instructed to covertly practice the concept had excellent concentration and were moderately successful in correctly arranging photographs in the proper sequence. However, the transfer of this training to the required performance was limited. The group mean for this practice condition was 201.17.

An analysis of variance was performed across the five treatment conditions. The results of this analysis are given in Table 24.

The F value for the analysis was 7.47 with a probability level of 0.0002. An R squared value was calculated to determine whether the effects associated with the analysis of variance model were of practical significance. The r^2 value of .47 showed large effects attributable to the model with 47% of the variance being accounted for.

Table 24

Analysis of Variance Across Five Treatment Conditions in a Praxiological Concept Learning Task

Source of Variance	DF	SS	MS	F	P
Total	38	2138044.77			
Model	4	1000356.61	250089.15	7.47	0.0002
Error	34	1137688.16	33461.47		

$r^2 = .47$

Because the analysis of variance indicated that there were significant differences among the groups, a Duncan's multiple range test was figured to further compare the means, Duncan's test, with the alpha level set at .01, with 34 degrees of freedom found that the only significant differences between the groups were associated with the overt practice groups (group D in Table 23) which had good concentration. The mean score for the overt practic /good concentration groups was significantly different from (greater than) the means for all of the other groups. No other means differed significantly.

These results, although subject to the previously discussed limitations, permit the following tentative conclusions.

The performance of educationally handicapped students may be adversely affected by instruction which does not allow overt practice after certain steps in a task have been demonstrated. Nothing in this research indicated how many steps can be demonstrated before practice is needed. The nature of the task would be a determining factor in this regard. One point can be made, however. Some skills are sufficiently involved so that they need to be taught task by task.

When Clark (1966) conducted the study a live video presentation was used to present the concept. A video presentation was prepared for use in this study and was shown to a small number of handicapped students. The students found the video presentation to be too abstract. Their performance on the tasks was negligible. Therefore, that mode of presentation was dropped from the experiment. Again, had the film been shown in toto as is frequently done in vocational classes, learning for the students in this study without a doubt would have been very limited.

Covert practice for this task resulted in less learning than overt practice. Some positive effects may have resulted from arranging photographs in a sequence which follows the steps actually followed in bending electric metallic tubing. These effects, however, did not result in the level of performance attained by students who overtly practiced making the bends following each demonstration.

Another factor that was evident in the performance scores and was visibly evident to the researchers was the effect of instructional climate. When the groups were interrupted and the climate was unstructured, attention was visibly diminished The unstructured climate in vocational education is subject to numerous interruptions. An instructor frequently must attend to several groups of students simultaneously and not be aware of the level of concentration of his or her students when instruction is being given. Learning in part is a factor of time on task. Clear, direct instruction that is geared to the level of the student, instructional tasks that are broken down to a level where students can respond correctly and frequently (whether verbally or physically), and a learning environment that is undistracted and motivating are ingredients that make vocational education meaningful and beneficial for students with learning problems.

A large amount of research on teaching complex technical tasks to students with severe developmental delays and mental retardation is being conducted. Gold, Bellamy, Brown, York and many others have demonstrated that complex motor tasks can be taught to persons with much less learning potential than the students admitted into mainstream vocational programs. The success that these researchers achieve is based on the belief that even severely handicapped persons can learn complex tasks and the willingness to break the tasks down in logical ways (and novel ways sometimes) and to create a learning environment in which student responses can be made frequently and corrected imeediately. There is no magic involved nor are psychological principals involved to which only psychologists and learning theorists are privy. This research project pointed out that big differences can be made by making little manipulations in the instructional procedures and the instructional climate.

SUBSTUDY III

A Search for Educational Factors Which Correlate Significantly With Employer Ratings

This substudy was conducted for the purpose of determining educational factors or combinations of factors which have a positive and significant correlation with employers ratings of on-the-job performance. The practical significance of the study was to identify variables which counselors and teachers can take into consideration when developing educational experiences for employment preparation. The study was modeled after an investigation by Lewis (1976).

Lewis investigated a series of variables to determine the extent to which they predict successful postschool employment of handicapped students (principally students with retarded mental development and specific learning disabilities). By identifying educational factors which account for successful occupational adjustment and advancement, Lewis hoped to devise a high school curriculum for handicapped students which would lead to successful postschool employment.

Previous research (Dunn, 1973; Frankel, 1973) had pointed out the need for an indepth look at the factors leading to successful occupational adjustment of handicapped students who had been graduate from work-study and vocational education programs. So, Lewis arranged to investigate the degree of correlation between several educational factors and job advancement.

Lewis found that out of thirty variables, only the following variables contributed positively to a job success prediction equation.

1) Chronological age
2) Length of service by vocational rehabilitation
3) Total social adjustment score
4) Attention to instructions
5) Ability to follow directions, and
6) Emotional control

In a related analysis, Lewis found no significant differences between a group of former students who had job advancements and a group which did not receive advancements with respect to: (1) sex, (2) ethnicity, (3) type of handicapping condition, (4) family status, (5) time elapsed since graduation, (6) type of services received in school, (7) I.Q., (8) math achievement, (9) reading achievement, (10) spelling achievement, (11) length of vocational rehabilitation services, and (12) a composite score for social adjustment.

The group of students advancing on the job differed from the non-advancing group on only one factor - the ability to maintain positive relationships with others.

The study reported here was an extension of the research conducted by Lewis. A correlation analysis was performed in an attempt to identify factors which correlate positively and significantly with positive employer ratings.

Description of the Subjects

Originally, educational data was assembled for 87 students, but employer ratings (the dependent variable) could not be obtained for 30 of these students, thus the final sample consisted of 57 students. The students came from a school district of approximately 20,000 scholastics. About 3/5 of the school population were of Anglo-American background, about 1/5 were of Afro-American background, and about 1/5 were of Mexican-

American ancestry. Males outnumbered females in the study by 2 to 1.

The students came from homes which represented a wide range of socioeconomic status. The majority of students came from families where the principal wage-earners were employed as common laborers or tradesmen. A limited number of the students came from families where one or more parents were engaged in commerce or the professions.

None of the former students actively participated in community clubs or activities, such as fund drives, volunteer work, or little league. However, nearly half of them had church memberships, and several of them were active participants in church activities. Approximately one-tenth of the students had been arrested and incarcerated for at least a 24-hour period. The majority of the former students reported that they spend their leisure time in watching television, visiting friends in each other's homes, and traveling about the community.

Correlation Analysis

Employer ratings were designated as the dependent variable in the correlation analysis. These ratings were derived from an Employers' Rating Form which had been completed for 57 students involved in the study. A Likert-type rating scale was used with the following designations:

A rating of

1 -- designated unsatisfactory performance,

2 -- designated poor performance,

3 -- designated fair performance,

4 -- designated good performance, and

5 -- designated excellent performance.

The ratings were given by the employers for five factors:

(1) Attitude toward employer (supervisors)

(2) Attitude toward company and co-workers

(3) Ambition, motivation, and desire to get ahead

(4) Pride in the quality of one's work

(5) Concern for productivity

Using a preprogrammed correlation analysis (SAS Correlation Analysis, see Chapter 3), a series of Pearson product moment correlation coefficients was determined for 31 independent variables. The mean, standard deviations, and ranges of scores (where measures of central tendency could be calculated) on which the correlation analyses were based are given in Table 25.

The median age of the group was 19; the mean I.Q. was 78.73 with a standard deviation of 11.8 (showing that there was a considerable scattering of scores).

The former students had achieved a mean reading level of 4.2, a math level of 4.4, and a spelling level of 4.2 prior to leaving school. They had spent an average of 5.1 years in special education.

The data specified above came from the former students' cumulative records which were accessed and analyzed by the school district's special education psychologist. No personally identifiable data was released to the authors of this study at any time. The school district psychologist was employed as a consultant to perform all analyses in which personally identifiable data was involved.

The correlation of these independent variables with employers' ratings for five factors plus a combined ratings factor are given in Table 26.

TABLE 25

MEASURE OF CENTRAL TENDENCY FOR CERTAIN FACTORS CALCULATED IN THE CORRELATION ANALYSES

Variable	N	Mean	Standard Deviation	Range Minimum	Range Maximum
I.Q.	57	78.74	11.80	44.0	108.0
Reading	57	4.15	1.69	0	8.9
Math	57	4.38	1.84	0	9.2
Spelling	57	4.18	1.58	0	8.4
Number of years in special ed.	57	5.07	2.99	1.0	11.0
Cooperation	57	3.01	0.83	1.0	5.0
Effort	57	3.39	1.33	1.0	5.0
Attention to instruction	57	3.47	0.93	1.0	5.0
Follow-thru on assignments	57	2.62	0.75	1.0	4.0
Ability to follow directions	57	3.31	1.09	1.0	5.0
Dependability	57	3.29	1.12	1.0	5.0
Perseverance	57	3.14	1.26	1.0	5.0
Purchasing habits	57	28.90	5.63	0	35.0
Budgeting	57	25.63	4.72	13.0	33.0
Banking	57	23.44	4.70	5.0	31.0
Job behavior	57	23.11	4.58	3.0	29.0
Job search skills	57	27.71	5.80	0	31.0
Home management	57	23.57	5.89	0	33.0
Health care	57	23.38	5.03	0	30.0

Table 26

Correlation Coefficients and Probability Levels for Selected Dependent and Independent Variables

Independent Variables	Dependent Variables					
	Combined Ratings	Attitude Toward Employer	Attitude Toward Workers	Ambition/ Motivation	Pride in Work	Productivity
I.Q.	-0.076 0.576	-0.109 0.421	-0.045 0.737	-0.031 0.818	-0.066 0.625	-0.150 0.264
Reading	-0.065 0.631	-0.176 0.191	-0.103 0.447	-0.001 0.995	-0.001 0.994	-0.025 0.855
Math	0.027 0.838	-0.069 0.612	-0.054 0.688	0.156 0.246	0.083 0.538	-0.003 0.981
Spelling	-0.152 0.259	-0.103 0.447	-0.244 0.068	0.028 0.837	-0.098 0.468	-0.114 0.398
Years in Spec. Ed.	0.342 0.009	-0.054 0.688	0.242 0.070	0.257 0.054	0.378 0.003	0.332 0.011
Prevoc. Class	0.242 0.070	0.298 0.024	0.164 0.224	0.102 0.450	0.278 0.037	0.247 0.064
Voc. Adj. Class	-0.242 0.070	0.298 0.024	-0.164 0.224	-0.102 0.450	-0.278 0.037	-0.247 0.064
Cooperation	0.174 0.196	0.161 0.232	0.063 0.639	0.212 0.114	0.143 0.289	0.194 0.148
Effort	0.098 0.470	0.063 0.641	-0.002 0.987	0.163 0.226	0.107 0.426	0.099 0.461
Attention to Instruction	-0.026 0.849	-0.037 0.787	-0.066 0.623	0.090 0.504	-0.057 0.674	-0.050 0.711
Follow-Through on Assignments	-0.037 0.782	-0.083 0.540	-0.102 0.451	0.080 0.553	-0.372 0.784	-0.034 0.780
Ability to Follow Directions	0.038 0.778	-0.020 0.883	-0.026 0.848	0.132 0.327	0.078 0.566	0.001 0.996

Table 26 (con't.)

Independent Variables	Dependent Variables					
	Combined Ratings	Attitude Toward Employer	Attitude Toward Workers	Ambition/ Motivation	Pride in Work	Productivity
Dependability	0.132 0.329	0.146 0.280	0.106 0.435	0.046 0.737	0.159 0.237	0.136 0.315
Perseverance	0.057 0.672	0.071 0.601	-0.025 0.853	0.087 0.518	0.110 0.414	0.011 0.933
Purchasing Habits	-0.045 0.741	-0.151 0.263	-0.078 0.563	0.054 0.687	-0.024 0.860	-0.013 0.923
Budgeting	0.125 0.353	0.034 0.801	0.068 0.616	0.176 0.190	0.144 0.284	0.131 0.330
Banking	0.099 0.465	0.047 0.729	0.095 0.480	0.151 0.262	0.092 0.496	0.056 0.680
Job Behavior	0.126 0.352	0.013 0.928	0.128 0.343	0.202 0.133	0.136 0.314	0.080 0.555
Job Search Skills	0.018 0.895	-0.103 0.445	0.025 0.852	0.147 0.274	-0.019 0.886	0.022 0.873
Home Management	0.003 0.982	0.010 0.939	-0.027 0.842	-0.010 0.942	0.024 0.862	-0.010 0.938
Health Care	0.056 0.679	-0.066 0.623	-0.004 0.975	-0.030 0.822	-0.070 0.604	-0.078 0.566
Hygiene/ Grooming	0.197 0.142	0.083 0.541	0.152 0.260	0.248 0.063	0.170 0.207	0.221 0.098
Functional Signs	0.090 0.506	-0.016 0.906	0.112 0.408	0.146 0.279	0.011 0.936	0.144 0.284

The combined ratings correlated significantly with only one variable, years in special education (r = 342, $p < .009$). Two other factors were close to significant in the degree of correlation with employer ratings, placement in a prevocational (work adjustment) class at the junior high school level and placement in a work adjustment class at the high school. A positive correlation was associated with the former independent variable and a negative correlation with the latter.

A significant negative correlation was noted for attitude toward employer and spelling. Attitude toward employer also correlated significantly with years in special education, work adjustment class at the junior high level, and work adjustment class at the senior high level (negative correlation).

Attitude toward co-workers and company correlated significantly with spelling (negative correlation).

Ambition, motivation, and desire to get ahead correlated significantly with years in special education. A close to significant correlation ($p < .06$) was calculated between ambition and grooming.

Pride in the quality of one's work correlated significantly with years in special education, work adjustment class at the junior high level, and work adjustment class at the senior high level (negative correlation).

Concern for productivity correlated positively with the number of years in special education. Nearly positive correlations for this variable were noted for work adjustment class at the junior high level and work adjustment at the senior high level (negative correlation).

Out of many possible positive correlations, few were noted. Employer ratings appear to be related in a positive sense only to the number of years spent in special education. No amount of guessing can adequately explain these findings. One would anticipate positive correlations between teachers' ratings of dependability and perseverance and employers' ratings of concern for productivity. But, these correlations had no significant relationship. Clearly, some students who are dependable and who follow through on assigned tasks in school must not appear to their employers as having a concern for productivity and as taking pride in the work. Conversely, some students must perform better for employers than the teachers. None of the positive traits that teachers recognized in students could be traced as a group in the employers' ratings of on-the-job performance.

Participation in a work adjustment class at the junior high level correlated significantly with employers' ratings of several traits. Such a finding makes sense. But what must yet be explained is why the same class at the senior high level correlated negatively with employer ratings. The purpose of the work adjustment class is to prepare students for the world of work and for succeeding in employment, that is, getting positive employer ratings.

All of the data fed into the regresssion equation used to generate the Pearson product moment correlation coefficients were checked and double-checked to make certain that no errors had been made. The facts remain, school administrators need to look beyond employers' ratings to identify factors which correlate positively with educational factors.

SUBSTUDY IV

The Influence of An Advanced Organizer On Vocational Concept Formation

Some concepts are learned more efficiently and quickly if the presentation of the concept is preceded by a special explanation or demonstration, that is, by something that puts the presentation into a context which facilitates learning. This is the function of an advanced organizer; it prepares the learner to acquire a particular concept with greater efficiency than would be possible without the advanced organizer. In this study, all students were taught the symbols for three types of values common to the plumbing industry. They were also taught the symbols for hot and cold water plus the symbols for welded pipe joints, soldered pipe joints, and threaded pipe joints. One group was prepared for the lesson through the presentation of a preparatory lesson, an advanced organizer. The second group received no prior instruction concerning the function of valves or valve symbols.

The advanced organizer for this lesson consisted of a discussion of the function of valves. A diagram of a petroleum plant was presented to the class together with an explanation of how valves were used to control the flow of gas, oil, and other petroleum products at the plant. The diagram depicted numerous valve symbols which were pointed out but were not explained in any way to the students. During the presentation, actual examples of several types of valves were passed around among the students. But again, only the function of valves was discussed. This explanation lasted approximately 12 minutes.

Both groups of students - the group whose instruction was preceded by an advanced organizer and the one receiving no preliminary instruction - were pretested. The pretest and the advanced organizer were both given on the day preceding the valve symbol instruction. The matrix pretest subtests were assigned to students as explained in Chapter 3.

Identical lessons were given to each treatment gorup and immediately following the lesson a posttest was administered.

A Kuder-Richardson 21 formula was used to determine the reliability for the two posttest. For the group given the advanced organizer, the KR21 reliability coefficient was .955 and .900 for the group which received no preliminary instruction.

Descriptive data for the study are given in Table 27. Performance on the pretest and posttest was virtually identical for both groups. Less than one point separated the groups on either test. The raw score pretest mean for the 10 students receiving the advanced organizer was 2.80 with a standard deviation of 4.92. The matrix (assumed group score) pretest mean was 8.60 with a standard deviation of 1.40 and a standard error of the measurement of 0.47. The matrix posttest mean was 26.07 with a

Table 27

Descriptive Statistics for Determining the Influence of An Advanced Organizer on Vocational Concept Formation

Treatment Condition	N		Raw Data $\bar{x}$	Raw Data SD	Matrix Data $\bar{x}$	Matrix Data SD	SE
Advanced Organizer	10	pre	2.80	1.23	8.60	1.40	0.47
		post	9.00	4.92	26.07	12.91	0.95
No Advanced Organizer	15	pre	3.00	1.81	9.08	4.28	0.39
		post	8.87	3.68	26.14	9.57	1.56

standard deviation of 12.91 and a standard error of 0.95.

The raw score pretest mean for the 15 students who did not receive the advanced organizer was 3.0 with a standard deviation of 1.81. The posttest raw score mean was 8.87 with a standard deviation of 3.68. The matrix pretest mean for the group not receiving the advanced organizer was 9.08 with a standard deviation of 4.28 and a standard error of 0.39. The matrix posttest mean was 26.14 with a standard deviation of 9.57 and a standard error of 1.56. These means were further analyzed in an analysis of covariance (see Table 28).

Table 28

Analysis of Covariance Across Two Treatments
(Advanced Organizer Versus No Advanced Organizer)

Source of Variance	DF	MS	F	P
Total	24			
Method	1	0.064	0.00	0.95
Covariate	1	1.359	0.07	0.79
Error	22	18.47		

$r^2 = .0036$

The treatment means did not differ significantly ($F_{1,24} = 0.00$, $p < 0.95$). On the contrary, they were practically identical. The covariate also was nonsignificant, indicating that the pretest did not materially affect the outcome of the analysis of covariance. The r^2 value for the analysis of covariance was small ($r^2 = .0036$). The small r^2 indicates that the statistical model accounted for a very small amount of variance.

Although the treatment conditions did not have different effects, both treatments resulted in significant learning. The pretest differed from the posttest in a significant way for both treatment conditions. For the advanced organizer lesson, the analysis of variance across the means was significant at the 0.001 level ($F_{1,20} = 33.50$, $p < 0.0001$). For the lesson which was not preceded by an advanced organizer, the pretest mean also differed significantly from the posttest mean ($F_{1,14} = 12.83$, $p < 0.006$).

What this experiment shows is that significant learning resulted from both instructional approaches, but the preliminary lesson failed to produce superior learning (at least in terms of immediate recall of valve symbols).

The total impact of the preliminary lesson (or advanced organizer) was not fully explored. Seeing actual examples of various valves and being told how they function in a petroleum plant may have influenced long term memory of these concepts and may have led to a better overall understanding of the use of valves in industry. These outcomes were not tested as the control question was limited to the effect of an advanced organizer on concept learning only. From this data, all that can be concluded is that the advanced organizer neither contributed to nor detracted from concept learning.

Some concepts may need to be explained in a larger context before being taught as discreet (even concrete) examples.

SUBSTUDY V

Comparison of Three Classifications of Students on a Vocational Concept Formation Task

The study compared the performance of three classifications of students (non-handicapped students, educable mentally retarded students, and students with specific learning disabilities) on a vocational concept learning task. The task consisted of learning to correctly identify seven plumbing symbols (the symbols for gate valves, globe valves, safety valves, hot water pipes, cold water pipes, threaded joints, welded joints, and soldered joints).

The students involved in the study attended a comprehensive high school in south central Texas. The total enrollment at the high school exceeded 950 students. The majority of the participants were of Mexican-American background (about 45%), the remainder came from Anglo-American families (about 30%) or Afro-American families (about 25%).

The students attended a school in which vocational education courses were offered, but none of the vocational curricula in which the students had enrolled included plumbing valves as concepts to be learned. (This is borne out by the similarity in pretest scores across the three groups.)

The students were randomly selected from larger pools of students. Following the administration of the pretest (see Chapter 3 for an explanation of the test used and the experimental procedures followed), a common lesson was given to the three groups of students. Instructional content and conditions were as close to identical as could be arranged in a high school setting. Following the lesson, a posttest was immediately administered, and the data were prepared for analysis.

The descriptive data for the study are reported in Table 27. The raw score pretest mean for the 10 non-handicapped students was 3.80 with a standard deviation of 1.93. The raw score posttest mean was 15.00 with a standard deviation of 0.00. Ten students received a perfect score on the posttest. The regular students had a matrix pretest mean of 11.40 with a standard deviation of 3.69 and a standard error of 1.24. The matrix posttest mean was 45.00 with a standard deviation of 0.00 and a standard error of measurement of 0.00.

Table 27

Descriptive Statistics for a Comparison of the Performance of Three Student Classifications on a Vocational Concept Formation Task

Treatment Condition		Raw Scores			Matrix Scores			
		N	$\bar{x}$	SD	N	$\bar{x}$	SD	SE
Regular Students	pre	10	3.80	1.93	10	11.40	3.69	1.24
	post	10	15.00	0.00	10	45.00	0.00	0.00
EMR Students	pre	6	2.50	1.23	6	7.50	5.62	1.82
	post	6	9.17	3.43	6	27.51	10.17	4.98
LD Students	pre	8	2.63	1.19	8	3.13	2.95	1.50
	post	8	10.38	3.82	8	31.14	10.75	3.50

The six EMR students had a raw score pretest mean of 2.50 with a standard deviation of 1.23. The posttest mean for this group was 9.17 with a standard deviation of 3.43. The matrix pretest mean for the EMR students was 7.50 with a standard deviation of 5.62 and standard error of 1.82. The matrix posttest mean was 27.51 with a standard deviation of 10.17 and a standard error of 4.98.

The eight LD students had a raw score pretest mean of 2.63 with a standard deviation of 1.19. The same group had a raw score posttest mean of 10.38 with a standard deviation of 3.82. The matrix (assumed group performance across all test items) pretest mean for the SLD students was 3.13 with a standard deviation of 2.95 and a standard error of 1.50. The matrix posttest mean was 31.14 with a standard deviation of 10.75 and a standard error or 3.50.

The group means were further analyzed by way of an analysis of covariance (see Table 28).

Table 28

Analysis of Covariance Comparing Three Students Groups On a Vocational Concept Formation Task

Source of Variance	DF	MS	F	P
Total	23			
Group	2	111.41	7.31	0.004
Covariate	1	8.35	1.10	0.310
Error	20	7.62		

$r^2 = 0.52$

The group means differed significantly ($F_{1,23} = 7.31$, $p < 0.004$). The covariate was not significant ($F_{1,23} = 1.10$, $p < .31$), indicating that the groups did not differ significantly on the pretest, nor did the pretest significantly influence the outcome of the analysis of covariance. The r^2 value for the analysis of covariance showed large effects associated with the statistical model. The model accounted for 52% of the assumed variance associated with the experiment.

To further analyze the group means which were reported to be significantly different, a Duncan's multiple range test was performed. At the alpha equal .01 level of significance, the non-handicapped students differed from the EMR students (20 degrees of freedom, mean square of 7.62). The non-handicapped students also differed from the SLD students at the same level of significance (.01). The EMR and SLD students did not differ in levels of performance.

The fact that the groups did not differ on the pretest but differed significantly on the posttest indicates that groups differed in efficiency of learning. The non-handicaped students were more efficient in learning the plumbing symbols. In fact, all ten of the students completely mastered the seven plumbing symbols in the 20 or so minutes of instruction given as the treatment. The superior efficiency demonstrated in this study would normally be multiplied many times in a typical comprehensive vocational curriculum or course of study. This factor is often cited as the reason for limiting enrollment in vocational courses to students of average or about average ability.

All three groups learned significantly. What this illustrates is the need for arranging assignments so that handicapped learners have opportunities for extra practice.

This study also points to the practicality of having multiple exit points in a vocational program. Because students will differ significantly in terms of efficiency of learning, the curriculum should reflect terminal objectives which differ in complexity.

This study also points out the need for adapting programs so that they accommodate the needs of handicapped students. Current regulations call for modifications to programs and for supplementary aids and services for handicapped persons. It is clear that supplemental assistance may be necessary to accommodate learners who differ significantly from the average student. The important point is that a wide range of students can learn significant numbers of vocational concepts and can be trained for entry level employment. That's the finding of greatest importance.

SUBSTUDY VI

Comparison of Instructional Materials Which Incorporate Concept Teaching Principles With Materials Which Do Not Incorporate These Principles

This substudy was developed to test the effects of omitting certain concept teaching principles from a lesson on common cutlery.

The lesson on common knives incorporating Clark's concept teaching principles was used as one lesson. A lesson for the comparison group was also developed. The lesson differed from the Clark-based lesson in the following ways. The visual materials for the alternative lesson did not include points (visual emphasizers) drawing attention to the critical and non-critical attributes of the concepts nor did they include pictures of non-examples. The script for the modified lesson did not include a discussion of critical and non-critical properties nor did it discuss non-examples. There were many similarities in the two lessons, however.

Both sets of visual materials included illustrations of positive examples of the various knives. Both sets of visual materials included illustrations of the functions of the knives, and both scripts included a discussion of the function of the knives. In addition, both sets of materials included practice questions and immediate feedback on the responses made. The immediate feedback consisted of telling the students the correct responses to the practice questions and explaining why the proper responses should have been given.

Students for the study were selected from a comprehensive high school. Criteria for being selected included: (1) placement in a special educational program (2) designation of handicapped according to state eligibility criteria, and (3) availability during the week in which the study would be conducted. The students were stratified by handicapped classification with an equal number of specific learning disabilities, educable mentally retarded, and seriously emotionally disturbed students assigned to each group. After stratifying the sample, students were assigned randomly to the experimental groups. The students were administered the pretest subtests on the day preceding the concept instruction. The experiment procedures discussed in Chapter 3 were following in administering the lessons and the posttests. The data also were prepared as discussed in Chapter 3.

The test items were analyzed for all subjects. A Kuder-Richardson 21 reliability coefficient was calculated for the tests administered to the students whose lesson incorporated concept teaching principles. The K-R21 for this group was .93. For students whose lesson did not incorporate Clark's concept teaching principles, the Kuder-Richardson 21 reliability coefficient was 1.60.

The descriptive statistics for the two experimental conditions are reported in Table 29.

Because of attendance irregularities, the two groups were not of equal size in the end. (An F_{max} test of homogeneity for analysis of covariance showed that the groups were homogeneous, despite having unequal numbers of subjects in the two experimental groups.)

The 21 students assigned to the instructional lesson which incorporated the principles of Clark's concept teaching paradigm had a mean raw score for the pretest of 7.38 and a standard deviation of 2.60. The posttest raw score mean for this group was 11.71 with a standard deviation

Table 29

Descriptive Statistics Comparing Lessons With and Without Concept Teaching Principles

Treatment Condition		Raw Data			Matrix Data			
		N	$\bar{x}$	SD	N	$\bar{x}$	SD	SE
Lesson With Concept Teaching Principles	pre	21	7.38	2.60	21	21.74	6.83	0.95
	post	21	11.71	3.26	21	34.61	9.50	2.50
Lesson Without Concept Teaching Principles	pre	15	7.53	2.80	15	21.80	7.05	2.40
	post	15	12.13	2.17	15	35.00	4.28	4.20

of 3.26. The matrix pretest mean was 21.74 with a standard deviation of 6.83 and a standard error of the measurement of 0.95. The matrix posttest mean was 34.61 with a standard deviation of 9.50 and a standard error of the measurement of 2.50.

For the 15 students assigned to the lesson which did not incorporate Clark's concept teaching principles, the raw score pretest mean was 7.53 with a standard deviation of 2.80. The raw score posttest mean for this group was 12.13 with a standard deviation of 2.17. The matrix pretest mean was 21.80 with a standard deviation of 7.05 and a standard error of 2.40. The matrix posttest mean was 35.0 with a standard deviation of 4.28 and a standard error of the measurement of 4.20.

To test for differences among these means, an analysis of covariance was performed with the pretest scores designated as the covariate or concomitant variable. The analysis of covariance is reported in Table 30.

The means for the two instructional methods were not significantly different ($F_{1,35} = 0.16$, $p < 0.69$). Thus, the null hypothesis of no

Table 30

Analysis of Covariance Comparing Lessons
With and Without Concept Teaching Principles

Source of Variance	DF	MS	F	P
Total	35			
Method	1	1.002	0.16	0.6939
Covariate	1	68.241	10.73	0.0025
Error	33	6.357		

$r^2 = .2496$

differences among the treatment effects was not rejected.

The covariate (pretest scores) figured in a significant way in the analysis of covariance ($F_{1,35} = 10.73$, $p < 0.0025$). The r^2 value for the analysis was .25, showing that the statistical model accounted for large effects (25% of the variance associated with the experiment).

The pretest and posttest means for each group were compared to test whether they were significantly different, that is, to test whether significant learning occurred in each experimental condition. The pretest and posttest scores for both experimental conditions differed significantly. For the group whose lesson incorporated concept teaching principles, the difference between pretest and posttest means was significant to the 0.000 ($F_{1,20} = 53.77$, $p < 0.0000$). For the group whose lesson did not incorporate concept teaching principles, the differences between pretest and posttest means was significant at the 0.0001. Both instructional conditions resulted in significant learning, but neither condition was superior.

The following conclusions are drawn from this experiment. The pretest scores for both groups were several points higher than the pretest scores obtained for less familiar concepts. Several of the students in both experimental groups knew or could accurately guess the identification of the different knives before instruction. These knives included 1) the utility knife, 2) the hunting knife, 3) the fish knife, 4) the Butcher knife, 5) the paring knife, 6) the pruning knife, and 7) and meat cleaver. Because the students had some previous knowledge of the identity and use of the knives, significant additional learning may have taken place regardless of the intensity of the instruction. Furthermore, because the students already had learned some of the concepts, the effect of giving explicit instructions on discriminating among positive and negative examples of the concepts was not as apparent as it might have been had the concepts been altogether unfamiliar and had the identifying attributes been more difficult to focus on.

When learning a totally unfamiliar concept, one must learn to identify the critical and non-critical properties (characteristics or dimensions). Otherwise, one does not know which features dictate whether an item is a positive concept instance or a non-instance. With familiar or partially familiar concepts such as common knives, we can assume that one has already learned certain identifying characteristics. With a knife, for example, one must focus on the blade, the handle, the heel of the handle, the tip of the blade, the type or types of blades, etc. to discriminate one knife from another. Once one has learned to discriminate a butter knife from a common table knife, from a meat knife, from a plastic picnic knife, etc., it may not be necessary to draw attention to the various critical and non-critical properties when teaching additional types of knives. The ability to make these mental distinctions may be transferred unconsciously from previous learning experiences and previous encounters with types of knives.

None of this is to imply that there are no advantages in using intensive and direct instructional approaches when teaching partially familiar vocational concepts. Although intensive and highly structured instructional strategies may not be needed to teach simple, immediate recall, the more intensive and structured instructional approaches may be necessary for long-term recall and for higher ordered learning.

This study was replicated in a small high school (at the request of a teacher of the handicapped). The results of the study were virutally identical. There were no significant differences in the treatment means ($F_{1,11} = 0.01$, $p < .92$). The results of the experiment are not discussed in this report, however, because too few of subjects were assigned to the experiment. The F_{max} test for homogeneity of variance showed that one group was not homogeneous.

SUBSTUDY VII

The Influence of Verbal Cues in a Vocational Concept Formation Task

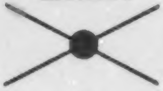
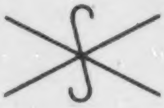
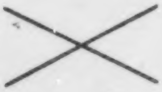
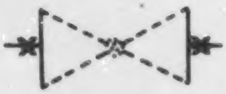
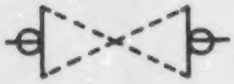
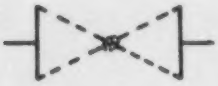
This substudy was designed to test whether verbal cues would facilitate the learning of vocational concepts for handicapped students. A further purpose was to test whether verbal cues would have different effects for different classifications of handicapped students, namely educable mentally retarded students (EMR) and learning disabled (LD) students.

The study was carried out in a suburban comprehensive high school in North Central Texas. All participants in the study were enrolled in a secondary work-study program and had been classified as EMR or LD following state eligibility guidelines.

The students ranged in age from 15 to 19. They had spent an average of five years in special education classes and were integrated into as many regular school activities as a multidisciplinary evaluation team considered practical. The students in the study represented the ethnic mix for the community, about 70% caucasion, 20% black, and 10% Mexican-American. The students came from families which represented a wide range of the socioeconomic spectrum. Attitudes toward work and school were mixed, with many of the students eager to complete school and to go to work under the assumption that employment would make it possible to own a car, travel, and "buy things when you want them."

Students for the study were selected from several classes for handicapped students. Students were stratified by handicapping condition and randomly assigned to two treatment groups. The procedures used to conduct the study are described in Chapter 3 as are the regular concept teaching materials used in the study. (See discussion on the development of plumbing valve materials.)

Both treatment groups received the same visual materials, a booklet depicting examples of plumbing symbols plus non-examples, and critical and non-critical attributes of positive examples. The scripts for the two groups differed. One group received a script that consisted only of technical terms and standard trade language. A second script was modified so that the use of technical terms was continued but verbal cues were also incorporated. The verbal cues consisted of expression which were intended to help the students to mentally associate certain technical terms with common and easily remained objects. Verbal cues were introduced into the script to facilitate the formulation of desired associations. The verbal cues (memory devices) used in the study are illustrated as follows:

Concept	Symbol	Verbal Cue
Globe Valve		Large X with a ball in the center
Safety Valve		Large X with a Superman Symbol in the center
Gate Valve		Large X
Welded Joint		"X" for flying sparks which come from welding with a torch
Soldered Joint		"O" for the beads that form when you solder
Threaded Joint		Staight end that looks like a "T" for "threaded"

Concept	Symbol	Verbal Cue
Cold Water Pipe	•—•—•	Dash dot, dash dot rhythmic pattern taught as verbal cues
Hot Water Pipe	••—••—••	Dash dot, dot, dash, dot, dot, rhythmic pattern taught as verbal cues

Altogether, there were seven verbal cues introduced into the instructional script for the plumbing valve lesson (see Appendix B for a sample script).

The groups were stratified by higher and lower ability levels, with the LD students representing the higher ability group. The rationale for the assumption that the LD students had higher ability is based on special education eligibility criterion. To be classified as EMR, a child must have an IQ lower than 72 concomitant with a measurable impairment in adaptive behavior. To be classified LD, a child must have at least average intellectual ability and have a severe discrepancy between actual and expected achievement.

The pretests (matrix subtests) were administered to the stratified randomly assigned treatment groups in the manner described in Chapter 3. On the following day, the two treatments were administered and an immediate posttest was given. The results of the pretest and posttest are given in Table 31.

For the EMR students who received the concept lesson with verbal cues incorporated into the script, the pretest mean raw score was 1.50 with a standard deviation of 1.07. The posttest mean was 7.88 with a standard deviation of 3.56. The matrix (assumed performance) mean pretest score for this group was 4.5 with a standard deviation of 1.35 and

TABLE 31

Descriptive Statistics For A Study Comparing Two Classifications of Students and Verbal Cues Versus No Verbal Cues in a Concept Formation Task

Treatment Condition	Raw Data				Matrix Data				
	Group	Test	$\bar{x}$	SD	Group	Test	$\bar{x}$	SD	SE
Concept Paradigm w/Verbal Cues	EMR (8)	Pre	1.50	1.07	EMR	Pre	4.5	1.35	0.00
		Post	7.88	3.56		Post	21.75	4.61	7.50
	LD (15)	Pre	2.60	1.59	LD	Pre	8.40	2.64	1.82
		Post	12.27	2.19		Post	37.15	2.99	4.94
Concept Paradigm w/o Verbal Cue	EMR (11)	Pre	2.73	1.56	EMR	Pre	7.69	2.64	1.82
		Post	10.27	2.61		Post	30.51	7.05	1.12
	LD (9)	Pre	4.33	1.80	LD	Pre	13.50	4.71	1.50
		Post	11.11	3.89		Post	32.17	13.54	3.50

a standard error of 0.00. The matrix mean posttest score was 21.75 with a standard deviation of 4.61 and a standard error of 7.50.

The raw score pretest mean for the LD students was 2.6 with a standard deviation of 1.59. The posttest mean for this group was 12.27 with a standard deviation of 2.19. The matrix mean pretest score for the LD students was 8.4 with a standard deviation of 2.65 and a standard error of 1.82. The posttest mean score for the matrix data was 37.15 with a standard deviation of 2.99 and a standard error of 4.94.

The raw score pretest mean for the EMR students who received the concept lesson without verbal cues incorporated into the script was 2.73 with a standard deviation of 1.56. The posttest raw score mean for this gorup was 10.27 with a standard deviation of 2.61. The matrix pretest mean score for the EMR students whose lesson did not include verbal cues was 7.69 with a standard deviation of 2.64 and a standard error of 1.82. The matrix posttest mean score for the EMR group was 30.51 with a standard devication of 7.05 and a standard error of 1.12.

The pretest raw score mean for the LD students who did not receive verbal cues in their instruction was 4.33 with a standard deviation of 1.80. The posttest raw score mean for this group was 11.11 with a standard deviation of 3.89. The matrix pretest mean score for the LD students who did not have verbal cues was 13.50 with a standard deviation of 4.71 and a standard error of 1.50. The posttest matrix mean score for this group was 32.17 with a standard deviation of 13.54 and a standard measure of 3.50.

These means were compared in 2 X 2 factorial analysis of covariance (see Table 32). The group means were found to be significantly different at .003 ($F_{1,38} = 10.30$, $P < .003$).

TABLE 32

2 X 2 Factorial Analysis of Covariance Across Two Student Classifications and Two Treatment Conditions (verbal cues)

Source of Variation	DF	MS	F	P
Total	42			
Group	1	88.29	10.30	.003
Method	1	13.68	1.60	.214
Group/Method	1	27.89	3.25	.079
Covariate	1	19.18	2.24	.143
Error	38	8.57		

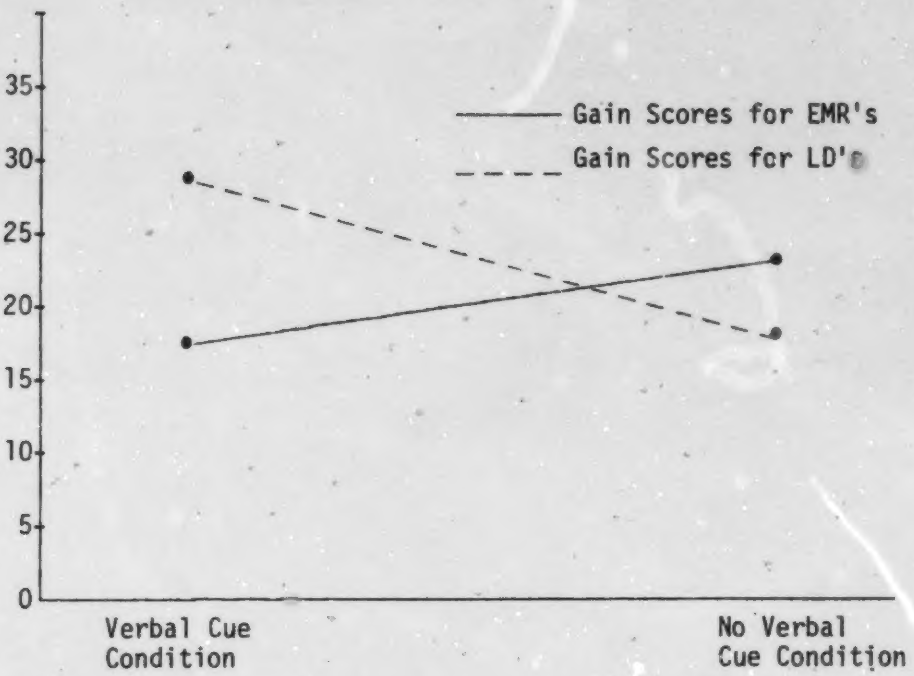
$r^2 = .275$

The treatment means were not significantly different ($F_{1,38} = 1.6$, $P < .214$). The interaction was not significant at the pre-established alpha level of .05 ($F_{1,38} = 3.25$, $P < .079$). The F value for the covariate was 2.24 with a probability level of .143, meaning that the groups did not differ significantly on the pretest and therefore the pretest as a covariate did not significantly contribute to the outcomes of the analysis of covariance. The r^2 value for the analysis of covariance showed large effects with the model accounting for 28% of the assumed total variance.

Based on the outcomes of the analysis of covariance, the hypothesis of no differences between the performance levels of the EMR students and the LD students was rejected. The differences were significant and favored the LD students overall. The interaction of treatment condition and student classification, though not significant at the α .05 level, was close to significant (.08). The nearly significant interaction can be seen in Figure 16 where the gain scores for the two classifications of students have been plotted across the two treatment conditions.

FIGURE 16

Graphic Illustration of the Interaction Trend
Apparent in the Analysis of Covariance



In terms of gain scores, the LD students had a mean matrix score gain of 28.75 for the verbal cue condition. The gain for the LD student in the no verbal cue condition was only 18.67, 10 points less than the gain for the verbal cue condition. The mean matrix gain score for the EMR students in the verbal cue condition was 17.25; for the no verbal cue condition, the mean matrix gain score was 22.82. The gain score for the EMR's was nearly 6 points greater in the no verbal cue condition than in the verbal cue condition. The opposite effect was observed for the LD students. The LD students had a mean gain score for the verbal cue condition that was more than 10 points higher than the no verbal cue condition.

The differential effects of the two treatment conditions across the two students groups is difficult to explain. There may have been confounding factors such as level of attention during the treatment condition or differences in abilities that were not adequately accounted for by the stratified random assignment of students to the treatments. But, the possibility exists that the verbal cues distracted the EMR students from the actual task. No verbal cues were used in the testing situation, therefore unless the cues were remembered they would not have helped to form the concepts. In fact, they may have confused the EMR students by distracting their attention from the attributes that identify positive examples of plumbing symbols. If this can be said, the opposite must be said for the LD students. The verbal cues may have actually helped them to formulate correct plumbing symbol concepts and have helped them to remember the concepts.

Both treatment conditions resulted in highly significant learning for both groups. This factor should not be overlooked. The posttest means for the verbal cue conditions were significantly higher than the pretest means for this condition ($F_{1,22} = 58.77$, $P < .0000$). The posttest means for the no verbal cue condition were also significantly higher than for the pretest means ($F_{1,20} = 148.32$, $P < .0000$).

Across the two groups (EMR and LD students), the treatment conditions were not significantly different. Both conditions resulted in significant learning, but neither treatment was superior in terms of overall significance. The interaction trend, however, indicated that not rejecting the null hypothesis of no differences in the treatment conditions must be carefully weighed before any final conclusions are drawn from the data presented. Becuase the two student groups (EMR and LD) reacted differently to the two treatment conditions, further investigation is called for. This is not said as an academic response to the difficulty encountered when an interaction effect appraoches significance. It is said with the desire fod good teaching in mind. Whenever a teaching strategy detracts from the learning of one group and enhances the learning of another, that strategy should be fully investigated to determine if the effects will reoccur a significant number of times or were the results of the inability to control certain factors (including confounding factors) in a school-based research setting.

The conclusion at this point is simply this. Vocational instructors who are attempting to teach vocational concepts to students of widely differing ability levels should be aware that differences among students must be given consideration not only in the development of curricula, in designing evaluation criteria, in identifying program exit points, but in selecting ways to present concepts as well. Learning abilities and learning styles are both individualistic. For some students, novel ways may need to be identified to present concepts in a way that results in optimum learning.

SUBSTUDY VIII

A Comparison of the Effectiveness of Two Instructional Paradigms for Teaching Vocational Concepts to Handicapped Students

This substudy compared the effectiveness of two instructional paradigms - a concept teaching paradigm and a paired associate teaching paradigm. A single research question was posed: Do students who are given instruction using a concept learning paradigm differ significantly in efficiency of learning from students who are given instruction using a paired-associate learning paradigm. Three substudies were conducted, each of which featured a different vocational concept.

Fasteners

This substudy compared the two instructional approaches across three classifications of students sewed in a special education vocational facility, trainable mentally retarded, educable mentally retarded, and specific learning disabilities students. The experimental design for the study consisted of a randomized block design in which the blocks were synonymous with the three levels of the nonmanipulated factor, namely students classification.

Assignment of students to the two experimental conditions was completely randomized except that students of each classification were assigned to both conditions.

The purpose of this substudy was to compare the relative effectiveness of two instructional paradigms for teaching vocational concepts to mentally handicapped students. The paired-associate approach is actually the basis for the "concept teaching approach" except that the latter expands the paired-associate approach to include some discrimination learning components as well.

The statistical design for the substudy was a 2 X 2 factorial analysis of covariance and the experimental design was a simple pretest posttest design without a control group.

The purpose for eliminating the control group was to preserve as many students for random assignment to the experimental groups. Furthermore, in this design, a control group would have served no purpose because the question being asked was not: "Do these teaching methods work?" Rather, the question being raised was: "Do the two methods of instruction differ from each other in their effectiveness as instructional techniques?" From the standpoint of a true experimental design, the use of a control to answer the latter question would have been entirely superfluous.

The students who participated in the study attended a special vocational facility which was part of a larger school district. About 65% of the students were from Mexican-American backgrounds; about 5% were Afro-American backgrounds; and the remainder were from Anglo-American backgrounds. The students were all of high school age and lived in a major metropolitan area.

Development of the Paired-Associate Materials and Lesson

The materials for the paired associate lesson consisted of a set of 4 X 6 index cards onto which were printed line drawings of fasteners which corresponded in every detail to the line drawings in the concept teaching booklets. Each participant in the study received a set of the cards.

The cards were presented for periods of 10 seconds while the name of the concept was repeated for the benefit of the students. For example, a card of a flat head wood screw was shown. The students were instructed to look at the same card in their own set and were told the name of the concept: "This is a flat head wood screw."

Students in the paired associate group received the same formative and summative tests as the students who were instructed in the concept teaching paradigm.

The procedures followed in carrying out the study and in the preparation and analysis of the data are discussed in Chapter 3. The test scores were analyzed using a Kuder-Richardson 21 reliability formula (see explanation, Chapter 3). The KR_{21} reliability coefficients for the posttests were as follows. For the EMR students in the concept teaching treatment, the KR21 was .60, for the SLD's it was .70, and for the TMR's it was .60. For the EMR students in the paired associate treatment, the KR21 was .81, for the SLD's it was .82, and for the TMR's it was .91.

The descriptive statistics for the study are given in Table 33. Both raw data and matrix data are given.

Pretest performance in raw scores for all groups ranged between 1.10 for a TMR group to 3.0 for an EMR group. The same groups had mean matrix scores of 3.0 and 9.0 respectively. Posttest performance ranged from a low raw score mean of 1.20 to a high raw score mean of 8.13 and a low matrix mean score of 3.60 to a high mean matrix score of 21.75.

TABLE 33

Descriptive Statistics For A Concept Versus
Paired Associate Teaching Paradigm
Across Three Classifications of Students
(TMR/EMR/LD)

Treatment Condition	N		Raw Data $\bar{x}$	Raw Data SD	Matrix Data $\bar{x}$	Matrix Data SD	SE
Concept Task							
EMR	9	Pre	3.0	1.66	9.00	1.69	
		Post	5.11	2.71	15.31	4.54	
LD	9	Pre	3.22	1.99	8.41	3.51	
		Post	3.44	2.96	8.98	4.60	
TMR	10	Pre	1.10	1.29	3.00	2.63	
		Post	1.20	1.23	3.60	2.78	
P/A Task							
EMR	7	Pre	2.57	1.13	7.68	1.17	
		Post	6.43	1.81	16.79	6.48	
LD	8	Pre	2.50	1.07	7.88	.91	
		Post	8.13	2.70	21.75	6.54	
TMR	7	Pre	1.71	1.38	4.88	2.06	
		Post	3.71	2.50	9.00	7.63	

To test for significant differences among treatment and group mean, the pretests were designated as the concomitant variable or covariate and an analysis of covariance was performed using the raw score means (see Table 34). Significant differences were noted between both group means

($P \leq .0054$) and treatment means ($P \leq .0001$). Interaction between groups and treatment means was not significant.

TABLE 34

Analysis of Covariance Across Three Classifications of Students And Two Instructional Methods

Source of Variance	DF	MS	F	P
Total	49			
Group	2	63.20	5.91	.0054
Method	1	104.27	19.46	.0001
Group/Method	2	27.95	2.61	.085
Covariate	1	20.37	3.80	.058
Error	43	48.22		

$r^2 = .55$

The covariate was not significant ($F_{1,49} = 3.80$, $P < .058$). An r^2 valve of .55 was calculated indicating that the statistical model accounted for 55% of the total variance in the experiment.

A Duncan's multiple range test was performed to further analyze the differences between the group means. At an α level of .01 with 47 degrees of freedom, significant differences existed between the group means for educable mentally retarded (EMR) and trainable mentally retarded (TMR) students and for TMR and Learning Disabled (LD) students. There were no differences between EMR and LD students across the two groups within the Paired Associates group, there were significant differences (α = .01 with 19 degrees of freedom) between the LD students and TMR students. There were no differences between EMR and LD students and between EMR and TMR students. For the groups assigned to the concept teaching paradigm, there were significant differences ($\alpha = .01$ with 25 degrees of freedom) between the EMR group and the TMR group. No differences were noted between EMR and LD group or the LD group and TMR group. The finding of no differences between the LD and TMR group indicates that the LD group may not have performed to capacity.

This study has some important implications for teachers of the handicapped in vocational settings. First, the performance scores of the different groups pointed out that significant differences in learning efficiency (and learning rates by inference) exist between various classifications of handicapped students. In a classroom situation, the differences observed in this simple study would be even greater. Moreover, they would be cumulative in nature. That is, the LD students would continue to acquire concepts at a faster rate than the TMR students, forcing the instructor to create two instructional tracks. In this sense, this study points out the fallacy of creating a vocational curriculum or designing vocational programs for the handicapped _per_ _se_. If special curricula are called for, they should be designed so that they meet the unique learning needs of particular groups of handicapped students.

The instructional paradigms differed significantly with the larger overall means associated with the paried associate teaching paradigm. Within both the LD group and the TMR group, the difference between the two instructional approaches was significant. Both instructional paradigms produced significant posttest gains over the pretest, but for short term gains the paired associate pair was superior. This has important implications.

The paired associate paradigm is much simpler to arrange. Only positive examples of a concept need to be presented. It involves highly repetitive activity which could be easily conducted by an instructional aid or peer tutor. The effort to identify non-examples and critical and non-critical attributes can be eliminated without reducing the efficiency of learning. (In fact, in this study efficiency in learning was increased by eliminating these aspects of the lesson.) Perhaps the key to this finding lies in the fact that the concept being taught were relatively simple. By repeatedly viewing the paired associate stimulus cards (line drawings of fasteners), the students were able to learn to discriminate among the various fasteners and to recall the correct shape and form of five different fasteners. The test required the students to make some fine discriminations which the students learned to do from the paired associate exercise as well as the concept teaching exercise. This study should be repeated with the same concept and with more complex vocational concepts. One would expect that at a certain level of complexity it becomes necessary to attend to critical and non-critical properties and to distinguish between closely related or visually similar examples of a concept.

Another study should be made to see if the differences noted in this study would hold up over time. Had delayed posttests been administered, would the superiority of the paired associate paradigm held up?

Most important, this study points out that instructional approaches have different effects on learning. Experimenting with different instructional approaches may at times be necessary and may more frequently be quite beneficial.

Plumbing Symbols

The paired associate paradigm was again compared to the concept teaching paradigm in this substudy. This time a different concept was used, one that was more complex - plumbing symbols.

The materials for this substudy were developed in the same manner as for the previous substudy (see Chapter 3). Students were assigned to the treatment groups on a stratified randomized basis. An equal number of EMR, TMR, and LD students were assigned to each treatment level. In this substudy, however, a factorial analysis of covariance was not performed because there were not enough students in the three student categories to make meaningful comparisons among them.

The students attended a comprehensive high school. Many of them were enrolled in a prevocational work adjustment class. Few of them had ever participated in vocational education classes, and none of them had been exposed to plumbing symbols in a formal instructional sense.

Kuder-Richardson reliability coefficients were calculated for the posttests for both treatment groups. The KR_{21} reliability coefficient for the students assigned to the concept teaching paradigm was 0.962; the KR21 reliability coefficient for the group assigned to the paired associate paradigm was 0.941.

The descriptive statistics for the two treatment conditions are given in Table 35.

A concept teaching paradigm was used to teach plumbing symbols to a group of 14 students (see Chapter 3 for a description of the lesson and test materials). The students had a pretest mean raw score of 1.93

TABLE 35

Descriptive Statistics for a Paired Associate Versus a Concept Teaching Paradigm for Teaching Plumbing Symbol

Treatment Condition	N		Raw Data		N	Matrix Data		
			$\bar{x}$	SD		$\bar{x}$	SD	SE
Concept Teaching Paradigm	14	Pre	1.93	1.49	14	5.79	1.84	1.50
	14	Post	9.71	4.91	14	29.41	13.14	4.13
Paired Associate Paradigm	12	Pre	3.25	1.71	12	9.23	3.56	1.63
	12	Post	8.75	4.20	12	24.85	11.80	1.97

with a standard deviation of 1.49. The raw score posttest mean was 9.71 (out of a possible 15 points) with a standard deviation of 4.9. The matrix scores (assumed scores across all 45 test items) for the concept teaching group was 5.79 for the pretest with a standard deviation of 1.84 and standard error of the measurement of 1.50. The posttest matrix mean for this group was 29.41 with a standard deviation of 13.14 and a standard error of the measurement of 4.13. The large standard deviation for this group may be attributed to the fact that LD, EMR, and TMR students were grouped together, representing a wide range in ability.

The raw score pretest mean for the group which received paired associate instruction was 3.25 with a standard deviation of 1.71. The raw score posttest mean for this group was 8.75 with a standard deviation of 4.20. For the same group, the posttest mean score for the matrix data was 9.23 with a standard deviation of 3.56 and a standard error of the measurement of 1.63. The mean posttest score for the matrix data was

24.85 with a standard deviation of 11.80 and a standard error of the measurement of 1.97.

To test for differences among these means, an analysis of covariance was calculated (see Table 36).

TABLE 36

Analysis of Covariance Across Two Instructional Paradigms for Teaching Plumbing Symbols

Source of Variance	DF	MS	F	P
Total	25			
Method	1	.06	.00	.9568
Covariate	1	40.12	1.98	.1732
Error	23	20.30		

$r^2 = .09$

The analysis of covariance showed no differences between the means for the treatment conditions ($F_{1,23} = .00$, $P < .96$). The covariate (pretest scores) were not significant to the outcome of the analysis of covariate ($F_{1,23} = 1.98$, $P < .1732$). The r^2 value was .09, indicating that only medium sized effects were detected by the analysis of covariance model.

Unlike the finding in the previous comparison, neither instructional paradigm showed superior effects. It should be noted, however, that both paradigm resulted in significant learning. An analysis of variance between the pretest and posttest scores for both instructional approaches revealed significant gains between the pretest scores and the posttest scores. For the concept teaching paradigm, this difference was significant at the .0002 level ($F_{1,13} = 32.50$); for the paired associate paradigm, the difference was significant at the .0027 level ($F_{1,11} = 15.40$).

This study showed that the alternative instructional approaches were equally effective in teaching a rather complex vocational concept. The importance of this finding exists in the fact that one instructional paradigm can be prepared at much less expense and in much less time. Materials for the paired associate approach can be prepared virtually on the spot. Materials for the concept teaching paradigm involve much more time as illustrations of examples and non-examples and critical and non-critical attributes must be prepared for the lesson to be complete.

Identity and Functions of Common Cutlery

A third substudy was made comparing the effectiveness of a concept teaching instructional paradigm with a paired associate instructional paradigm. For this substudy, seven common knives and their functions were taught.

The development of the materials were developed as discussed in Chapter 3. (Also, the materials are illustrated in Appendix A). The dependent measure for the substudy was developed and field tested as discussed in Chapter 3. The students were selected from the secondary special education program of a high school of approximately 800 scholastics.

The students were enrolled in special classes for the educable mentally retarded (EMR) and the learning disabled (LD). The students were assigned to the two treatment conditions on a stratified randomized basis. An equal number of students from the two categories (EMR and LD) were assigned to the two experimental conditions.

A pretest and posttest were administered to the groups in the same manner as in the other paired associate versus concept teaching studies. The posttest for students assigned to the concept teaching paradigm had a Kuder-Richardson (KR_{21}) reliability coefficient of .896; for the group assigned to the paired associate paradigm the K-R 21 reliability coefficient was .914. The descriptive statistics for the two groups are given in Table 37.

TABLE 37

Descriptive Statistics for Two Instructional Paradigms for Teaching the Identity and Function of Common Cutlery

Treatment Condition	N		Raw Data		N	Matrix Data		
			$\bar{x}$	SD		$\bar{x}$	SD	SE
Concept Teaching Paradigm	7	Pre	7.29	3.73	7	21.86	10.11	0.0
	7	Post	11.86	2.85	7	35.57	7.74	0.0
Paired Associate Paradigm	7	Pre	5.43	2.70	7	15.95	9.83	2.38
	7	Post	10.43	3.46	7	31.29	9.45	0.0

The pretest raw score mean for the group of seven students receiving the concept teaching paradigm was 7.29 with a standard deviation of 3.73. The posttest raw score mean for this group was 11.86 with a standard deviation of 2.85. The matrix pretest mean for the concept teaching group was 21.86 with a standard deviation of 10.11. The matrix posttest mean was 35.57 with a standard deviation of 7.74.

The pretest raw score mean for the group of seven students receiving the paired associate paradigm was 5.43 with a standard deviation of 2.70. The raw score pretest mean was 10.43 with a standard deviation of 3.46.

The matrix pretest mean was 15.95 with a standard deviation of 9.83 and a standard error of the measurement of 2.38. The matrix posttest mean was 31.29 with a standard deviation of 9.45.

An analysis of covariance was performed to test for significant differences in the means (see Table 38).

TABLE 38

Analysis of Covariance Across Two Instructional Paradigms for Teaching the Identity and Common Uses of Seven Knives

Source of Variance	DF	MS	F	P
Total	13			
Method	1	.053	.01	.922
Covariate	1	43.84	5.47	.035
Error	11	6.78		

$r^2 = .58$

Because the small number of subjects available for the analysis of covariance, an F_{max} test of homogeneity for the analysis of covariance was performed. Homogeneity was found for both the pretest and the posttest ($F_{2,6} = 1.92$; and $F_{2,6} = 1.47$).

The F value associated with the group means was .01 with $P < .922$. Clearly, no differences existed between performance levels for the two treatments. The covariate (pretest) was significantly related to the outcomes of the analysis of covariance ($F_{1,11} = 5.47$, $P < .035$). An r^2 analysis showed large effects attributable to the model. The model accounted for 58% of the variance associated with the experiment.

As in the comparison of the two paradigms for teaching plumbing symbols, no significant differences were noted between the treatment conditions. There were significant differences, however, between the pretest and posttest measures for both groups. For the concept teaching paradigm, the difference between pretest and posttest means was significant at the .0038 level ($F_{1,7} = 22.10$). For the paired associate paradigm, the difference betweeen pretest and posttest mean scores was .0015 ($F_{1,7} = 35.00$).

As in the previous experiment, neither instructional paradigm was superior in terms of psottest performance (with pretest scores held as covariate). The significance of this finding lies in the fact that the paired associate paradigm is more economical to administer both in terms of materials necessary for the instructional presentation and in terms of the time required to prepare for instruction.

At some point in time, critical and non-critical attributes and non-examples (especially ones that look like positive examples) may need to be taught in order for students to fully learn a vocational concept. The research pointed out, however, that for simple immediate recall, a paired associate instructional paradigm may prove as efficient for teaching as a more elaborate and time consuming concept teaching paradigm.

CHAPTER 5

TEACHING VOCATIONAL SKILLS & CONCEPTS TO STUDENTS WITH SPECIAL NEEDS

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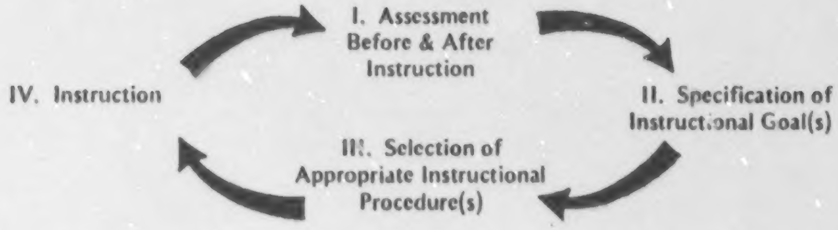
THE TEACHING/LEARNING ENCOUNTER

The teaching/learning encounter in vocational education is a complex phenomenon. Just as there is much more to operating a one-man retail business than tending the counter, there is much more to teaching a vocational course than explaining and demonstrating skills to a class of students. Teaching effectively like running a successful small business demands the skillful manipulation of hundreds of interacting variables. And anyone who says or implies that success in teaching can be achieved solely through the utilization of a particular approach to instruction (be it the engineered classroom, diagnostic prescriptive teaching, or personalized instruction) displays a limited understanding of both teaching and learning. This is not to say, however, that skill in teaching is like an art form that each individual must acquire for himself or herself. On the contrary, many prescriptions for effective teaching have been developed for use in appropriate instructional situations. The use of concept teaching strategies, for example, can improve learning for many students and, because of this, should be understood and appropriately utilized by vocational teachers.

The purpose of this mini-report is to describe how concept teaching strategies can be used to enhance the learning of vocational students—particularly students with special needs. The report also contains a discussion of research activities that were carried out to determine how selected variables influence the learning of vocational concepts by handicapped students.

Numerous attempts have been made to describe the essential elements of teaching. As one might expect, these descriptions differ somewhat in the terminology used and in the points emphasized; nevertheless, there is general agreement that the teaching/learning encounter involves certain essential elements. These elements are listed in Figure 1.

Figure 1
Elements of Instruction


I. Assessment Before & After Instruction
II. Specification of Instructional Goal(s)
III. Selection of Appropriate Instructional Procedure(s)
IV. Instruction

Entire courses of study have been built around each of the four elements shown in Figure 1 which implies that the teaching/learning encounter is far more complex than depicted in the diagram. Concept teaching strategies, for example, represent only one of many alternatives that should be considered in phase three of the diagram, the selection of appropriate instructional procedures for the attainment of specific instructional goals.

WHAT ARE CONCEPTS?

Concepts exist in the mind, not in the external world. They can be thought of as the mental photographs of things sensed (seen, heard, felt, smelled, or tasted); they can also be thought of as the mental constructs of non-sensed entities (abstractions, ideas, images, values, impressions, and the like). Herbert Klausmeier, a noted authority in verbal learning, defines the term concept as a mental construct or image "characterized by psychological meaningfulness, structure, and transferability" (p. 402). He notes that concepts enable individuals to cognize (or recognize) "things and events as belonging to the same class and as different from things and events belonging to other classes" (p. 402). Thus, concepts allow individuals to see relationships between things, events, and ideas.

Descriptively speaking, concepts can be simple or complex; they can be concrete (open-ended wrench, sabor tooth saw, microwave oven) or abstract (internal combustion process, photosynthesis, digestion). Concepts can be general (fastener), specific (flat head wood screw), or more specific (¼" by 1½" brass standard flat head wood screw). In relationships that are hierarchical in nature, concepts can be supra-ordinate (living things), coordinate (birds, mammals, fish), or subordinate (barn swallow, mule deer, speckled trout).

In vocational education, a particular set of concepts will be associated with each course of study. Included among these concepts will be the basic operations and processes used in an occupation plus the related equipment, tools, accessories, supplies, and materials. An important first step in developing a course of study in vocational education is the specification of the concepts to be learned.

PROCEDURES FOR TEACHING CONCEPTS

After specifying a concept to be taught, the first step in preparing to teach it is the identification of its critical and noncritical attributes. The critical attributes of a concept are those properties (characteristics, elements, or features) which every example of the concept must have. Consequently, removing a critical attribute causes an example of a concept to become a nonexample. Noncritical attributes, on the other hand, are those properties which can be removed or varied without changing the concept example to a nonexample. An essential step in teaching concepts is the listing of their critical and noncritical attributes. This analysis is then used to select appropriate instructional materials, examples and nonexamples of the concept. Markle and Tiemann (1969), authors of a widely used method for teaching concepts, suggest that the number of examples needed to teach a concept is equal to the number of its noncritical attributes. Hence, two examples of the standard flat head wood screw would be sufficient to teach the concept provided that the examples were different in size and color. An example of concept analysis is given in Figure 2.

Figure 2
Analysis of the Concept
"Standard Flat Head Wood Screw"

Attribute	Critical	Noncritical	Action Suggested
a) Color (or type of metal		X	Select examples which vary the colors (silver, brass, bronze, color coated)
b) Size		X	Select examples of varied lengths and diameters
c) Type of thread	X		Select nonexamples (machine screw thread)
d) Slot in head	X		Select nonexamples (phillips head)
e) Threaded portion of body	X		Select nonexamples (rivet, sheet metal screw)
f) Tapered bearing surface (shoulder)	X		Select nonexamples (lag screw)
g) Pointed base	X		Select nonexamples (flat head cap screw)

After reviewing more than 200 concept learning studies reported in the literature, Clark (1969, 1975) developed the following five-step format for teaching concepts: (1) identification of critical and noncritical attributes, (2) formation of an instructional objective, (3) selection of instructional materials, (4) presentation of the concept, and (5) evaluation of concept attainment. Using Clark's five-step format, a lesson for teaching the concept, standard flat head wood screw, would be developed as illustrated in the following paragraphs.

LESSON PLAN FOR TEACHING THE CONCEPT "STANDARD FLAT HEAD WOOD SCREW"

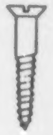
I. Identification of concept attributes
  A. Critical attributes:
    1. A flat head with a straight slot across the diameter
    2. A bearing surface (shoulder) that tapers inward toward the body
    3. An upper portion of the body (approximately one-third the length of the body) with no threads
    4. A lower portion of the body (approximately two-thirds the length of the body) with wood screw threads
    5. A pointed base
  B. Noncritical attributes:
    1. Type of metal or finish
    2. Size of diameter and length

II. Formation of an objective
  A. Following instruction, the student will have formed the concept "standard flat head wood screw." As evidence of this, he will be able to:
    1. Discriminate examples of the standard flat head wood screw from other types of metal threaded fasteners
    2. Distinguish between standard flat head wood screws and closely related nonexamples such as the flat head sheet metal screw, the flat head machine screw, and the flat head cap screw

3. Select previously unencountered examples of the concept from a wide array of metal threaded fasteners.

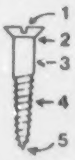
III. Selection of materials
   A. Select an example of the concept (same illustration as IV A)
   B. Select examples of the concept which illustrate noncritical attributes (same illustration as IV C)
   C. Select nonexamples which illustrate the lack of one or more critical attributes (same illustration as IV E)

IV. Presentation of the concept
   A. Introduce the concept by name



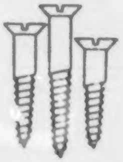
"This is a standard flat head wood screw."

   B. Illustrate each of the concept's critical attributes



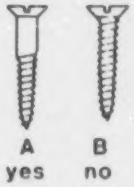
"Notice that the standard flat head wood screw has (1) a flat head with a straight slot across it, (2) . . . etc"

   C. Review critical attributes using a variety of examples. (This also illustrates the noncritical attributes)



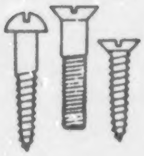
"Observe that standard flat head wood screws come in different sizes and colors, but they always have (1) . . . (2) . . . etc."

   D. Compare examples of concept with closely related nonexamples (discriminators)



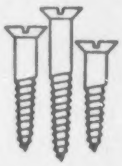
"Note that A & B look very much alike. A is a standard flat head wood screw, but B is not because the threads go all the way to the head."

E. Show nonexamples together and reemphasize why they are not examples



"None of these are standard flat head wood screws. Can you tell why?"

F. Review examples and attributes (Same illustion as IV C)

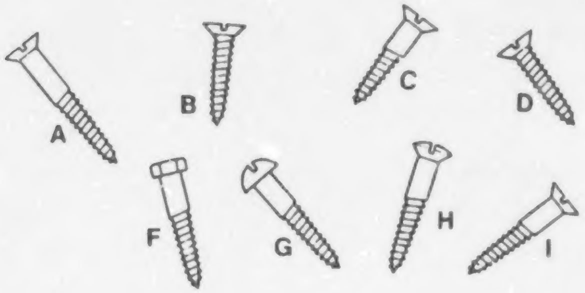


"Once again, standard flat head wood screws will always have (1) . . ., (2) . . . etc."

V. Evaluation of concept formation

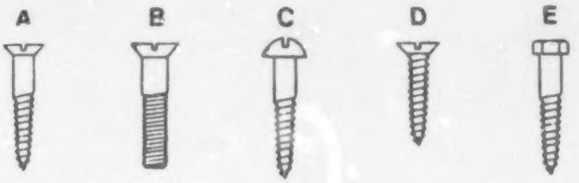
A. Formative evaluation

Immediately following the initial concept presentation, the learner is given an opportunity to practice identifiying the concept from an array of closely related concepts (illustrated below). Immediate feedback is given for each response made. If nonexamples are identified as examples, the teacher reviews the critical attributes of the concept to be learned. When the student has attained the concept, the teaching process is over temporarily.



B. Summative evaluation

After an appropriate interval, a final evaluation (illustrated below) is made to determine if the concept can be recalled following a lapse of time. If the student continues to perform to criterion, the concept is presumed to be mastered—and in all probability will be correctly recalled time after time if intermittent reviews of the concept are planned.



MORE ABOUT CONCEPT TEACHING

Thorough preparation for concept teaching is essential. With practice, however, the five-step method suggested by Clark becomes an easily followed routine. As previously noted, this method of teaching has proved to be very efficient for students with learning problems. Not all concepts, of course, need to be taught in the manner illustrated with the standard flat head wood screw; some concepts are more easily attained by a simple paired-associate teaching format: show it; name it; and repeat it until the concept is attained. But for important concepts, which have closely related nonexamples, the Clark five-step approach to concept teaching or some other systematic approach should be used.

To improve concept teaching, the following points derived from the literature also should be considered.

1. When initially presenting a concept, emphasize its critical attributes (properties or characteristics) and to the extent possible de-emphasize its noncritical attributes.

2. When pointing out the critical attributes of a concept, allow students ample time to examine the attributes and encourage the students to repeat aloud the names of the critical attributes.
3. Summarize the critical attributes of a concept repeatedly during the initial concept presentation and during periodic reviews.
4. Encourage active responding during concept presentations. Move at a stimulating pace but not so rapidly as to lose the student's attention.
5. Give sufficient feedback to the responses of students. (Both positive and negative feedback influences concept learning.)
6. Use both real examples and vicarious examples (examples which reduce the information load such as line drawings or photographs).
7. Use cartoons and visual emphasizers (arrows, pointers, boxes, underlining, etc.) to focus attention on critical attributes.
8. List the attributes of a concept in an outline form (enumeration or table) rather than in a straight text format.
9. Practice is essential in concept learning. Intermittent (spaced) practice is better than continuous practice that is not repeated at regular intervals.
10. Labeling the critical attributes of a concept facilitates concept learning. Labels should be as clear and simple as possible.
11. Often, it is better to present examples of a concept simultaneously (all together) rather than successively (one after another).
12. The greater the number of examples presented the greater the ease of concept learning.
13. Under certain conditions, imposing a risk condition (loss of points or other type of reward) can facilitate concept learning.
14. Concise, clearly stated definitions in conjunction with examples facilitate the learning of concepts.
15. Practice in forming concepts increases the ease with which related concepts are learned.

TEACHING MANIPULATIVE SKILLS (ACTION CONCEPTS)

In teaching a vocational concept which involves motor learning, many of the same principles apply that are followed in teaching cognitive concepts. Task analysis again is the key. While it is possible to teach technical skills and operations by simply demonstrating them, most skills will need to be broken down into small steps before they are taught. The question then arises: How small should the steps be?

The answer to this question depends in part on the ability of the learner. A task should be broken into small enough steps so that the learner with the most limited learning ability can perform each step successfully. The key to teaching a complex technical skill is to create a learning situation in which the learner can respond frequently and successfully.

Marc Gold is an eminent researcher in the area of training severely retarded individuals to perform complex technical tasks such as completing circuit boards and assembling bicycle brakes. His films, workshops, and writings are highly recommended for your further study.

Before teaching a complex technical task, Gold asks two sets of questions. First, he asks: What is the most appropriate method for completing the task? Sometimes different methods can be followed in performing a task. Based on knowledge of the learner, the instructor should first select the most appropriate method to be followed in completing the task. For example, in joining two boards to form a right angle, the instructor should first decide the type of joint to be formed and the types of fasteners to be used.

The second question Gold asks is this: Into what steps should the task be broken? The object is to break the task down into teachable components. The result of this process is a set of steps that resemble the instructions which you receive when purchasing an unassembled item.

Other decisions remain, including the selection of the most appropriate instructional methodology. What type of feedback (corrective information, coaching, positive reinforcement) should be given to the learner? How long should the learner be allowed to practice and at what intervals? On what order should the steps in the task be taught—in a forward order or a backward order? To what extent must the pupil overlearn the skill in order to retain it? These are examples of questions which a vocational instructor should ask an experienced special education teacher when preparing to teach a complex motor skill to a handicapped learner.

Many important points to be considered in teaching action concepts are reported in the literature. A few of the most important points that should be considered include:

1. In teaching a complex manipulative task, the task should be broken down into small steps which can be presented to the learner in the form of a carefully structured sequence in which frequent and successful responses can be made.
2. In teaching a long and complex manipulative task, an overview demonstration, followed by a repeated demonstration and student practice of the elements of the task may be superior to an entire demonstration without practice of the elements.
3. A complex motor skill may be learned in fewer trials and with greater proficiency following a distributed practice pattern than following a massed practice pattern.
4. Retention of a motor task is related to the degree of original learning. The greater the degree of overlearning the longer the retention.
5. Giving students a limited number of verbal cues (tips about positioning, etc.) may aid motor learning.
6. Although students classified as mentally retarded may have suppressed or inferior motor performance, about one in three retarded persons will have average motor ability.

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APPENDICES

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APPENDIX A

Instructional Materials Samples

i. Standard Flat Head Wood Screw with Formative Evaluation

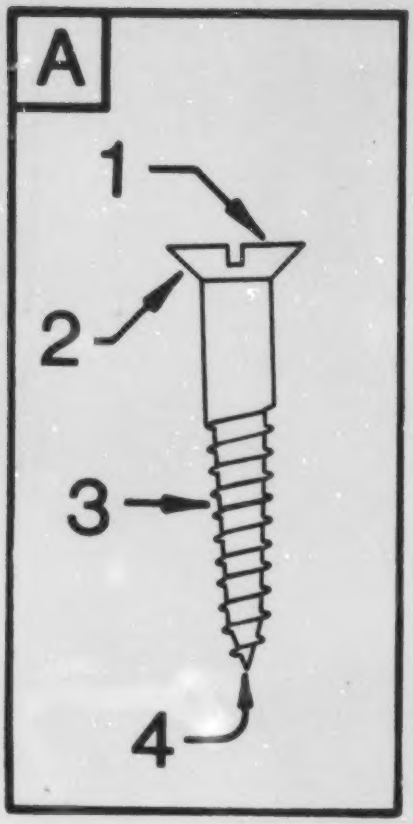
ii. Safety Valve Symbol with Formative Evaluation

iii. Paring Knife with Formative Evaluation

iv. Common Knives without Concept Teaching Format

Instructional Materials with
Formative Evaluation

Standard Flat Head Wood Screw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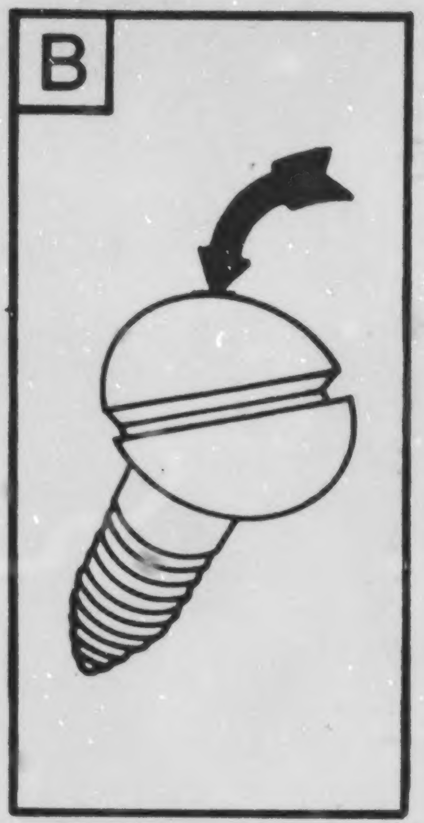
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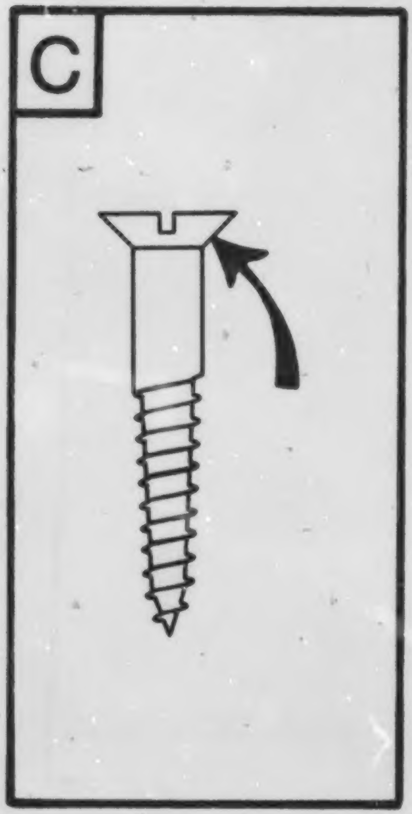
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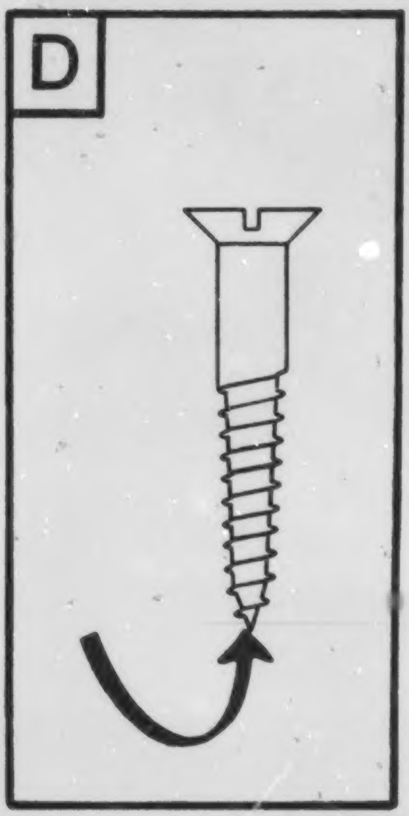
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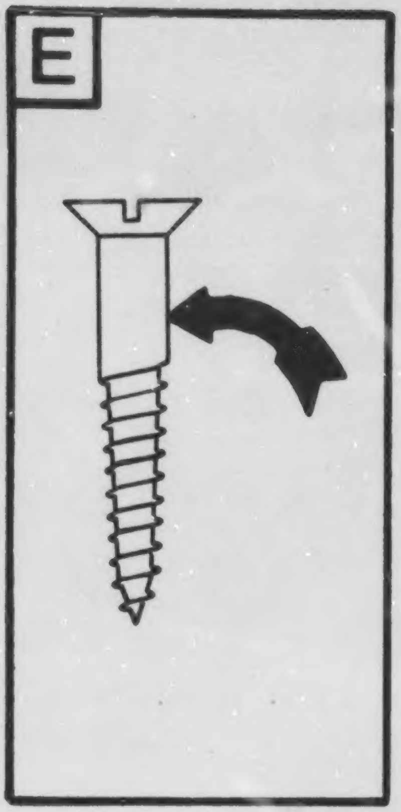
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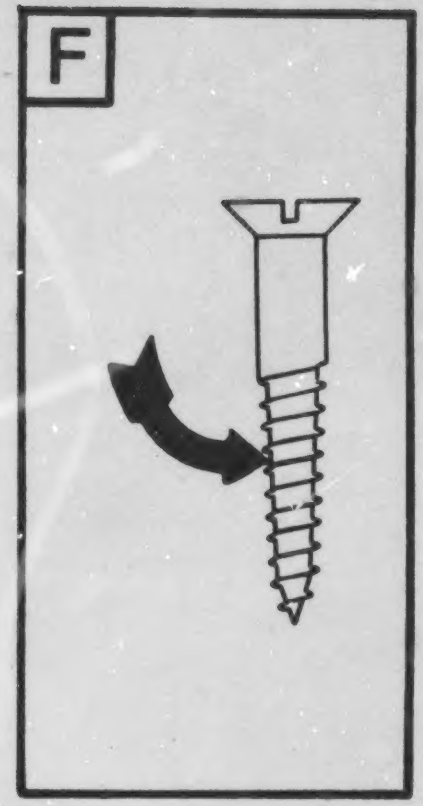
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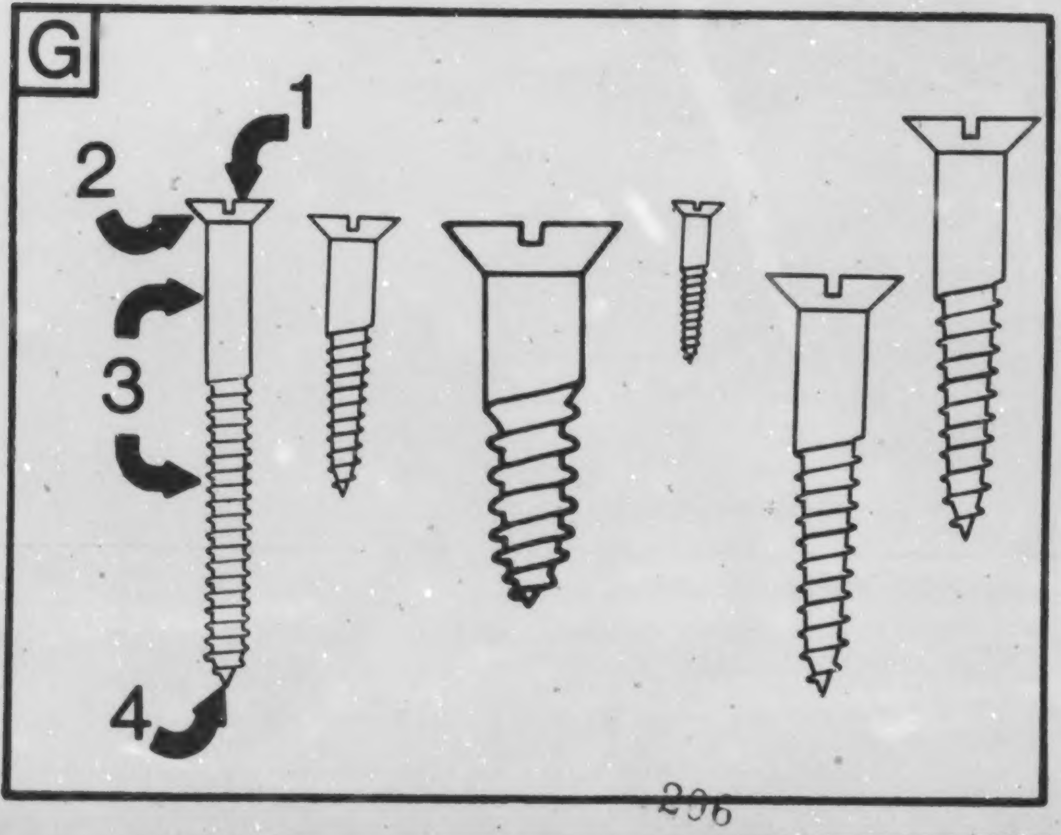
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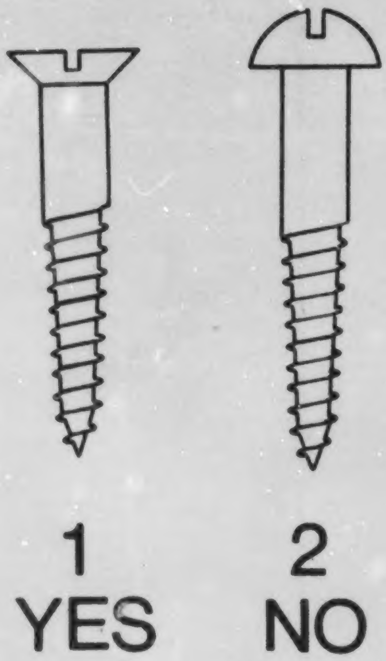

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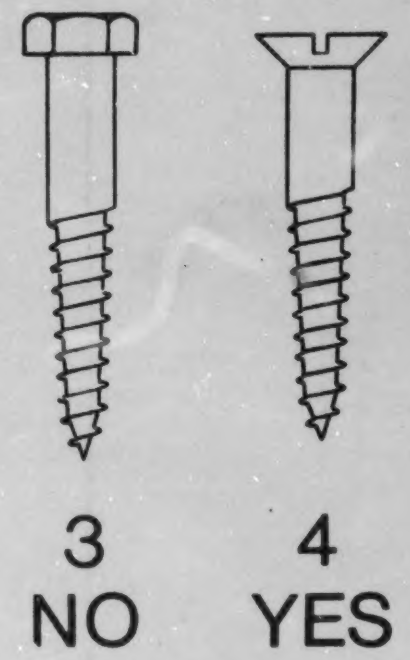

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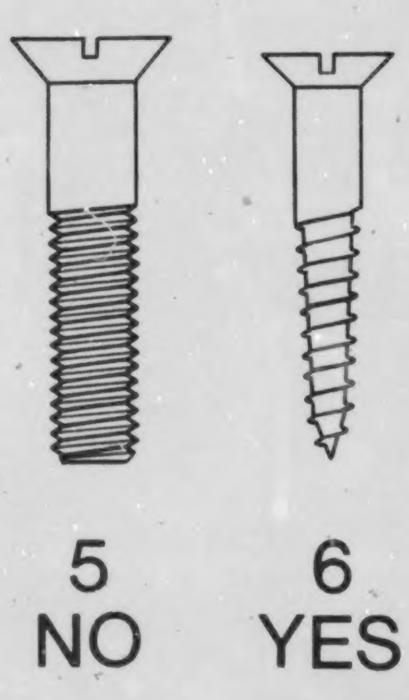

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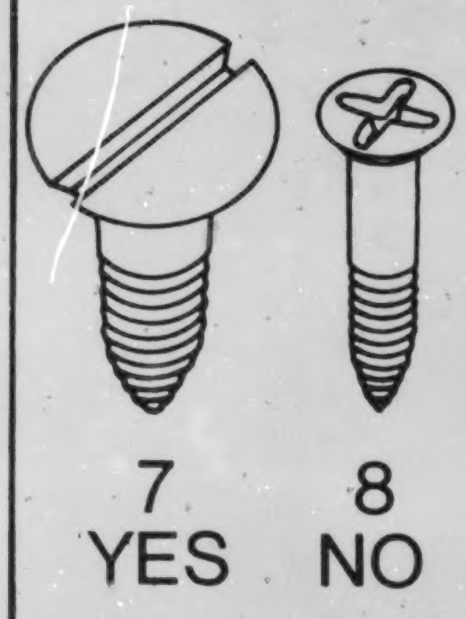

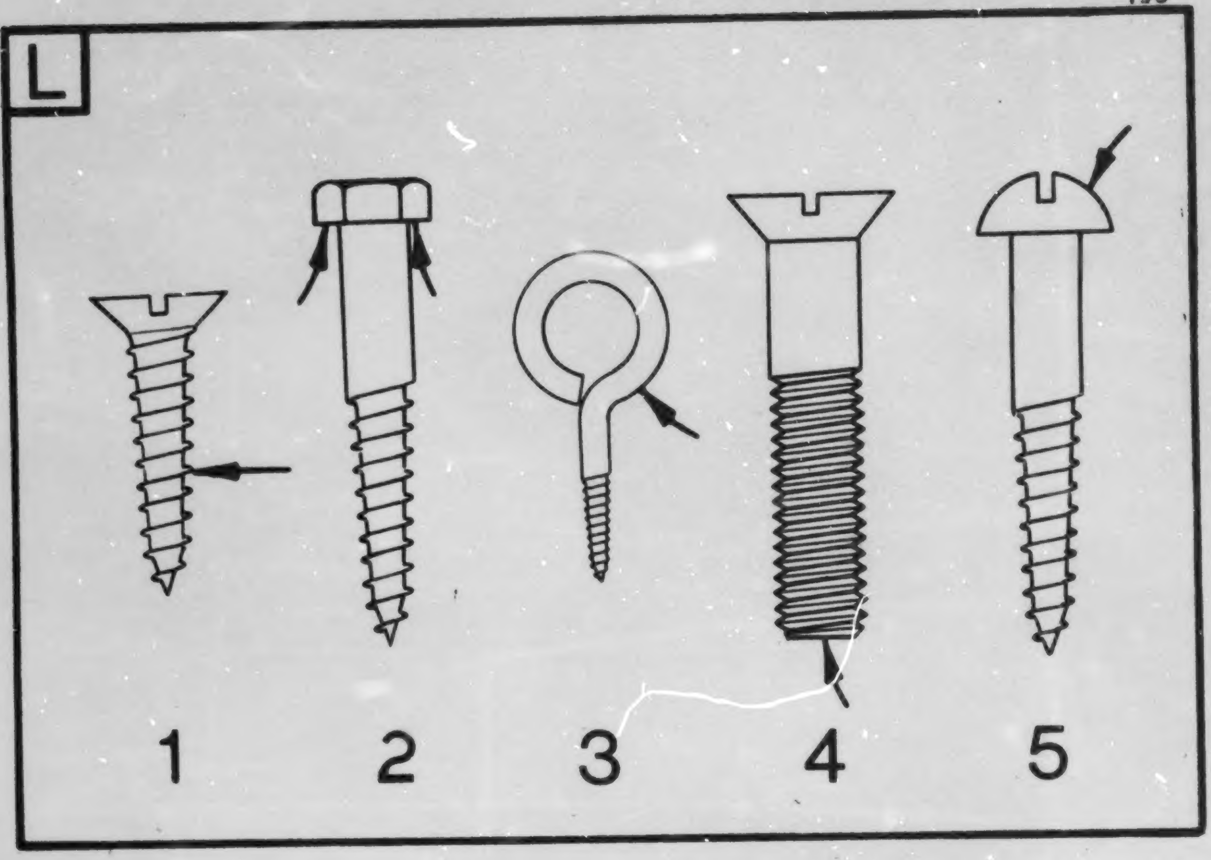
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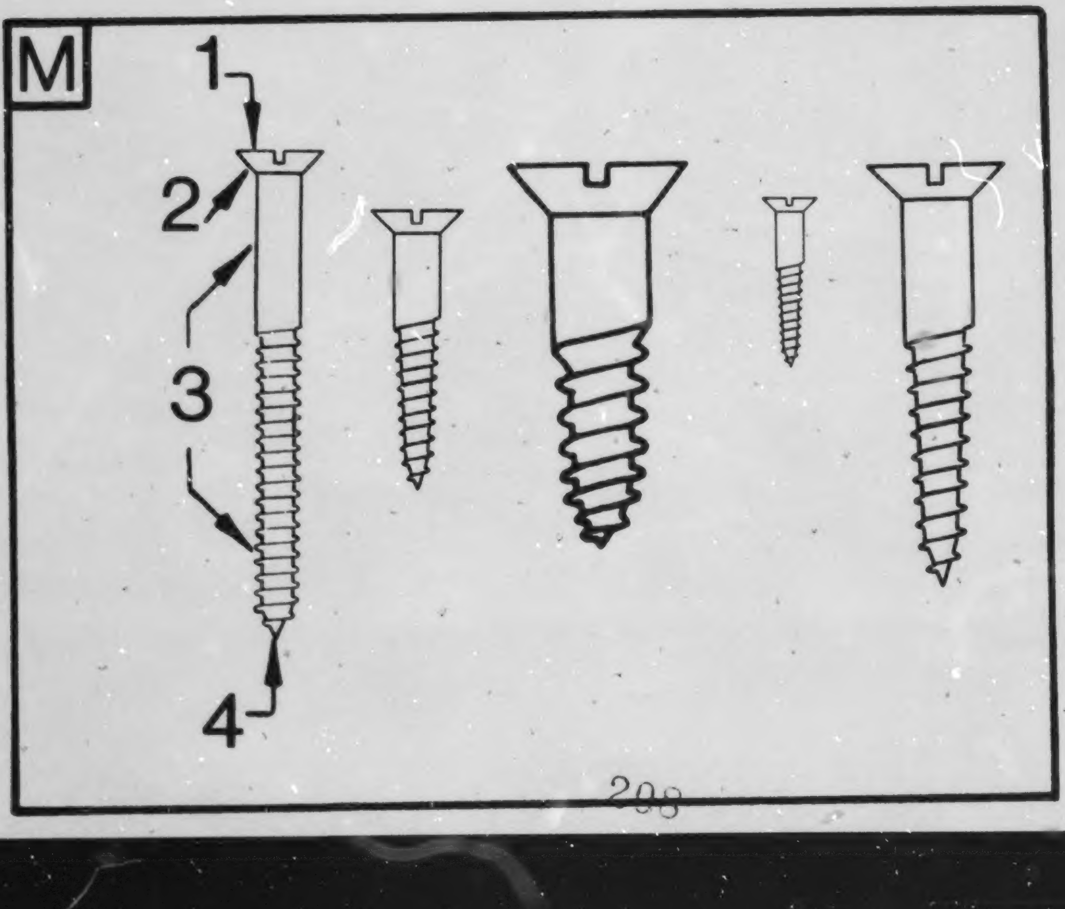
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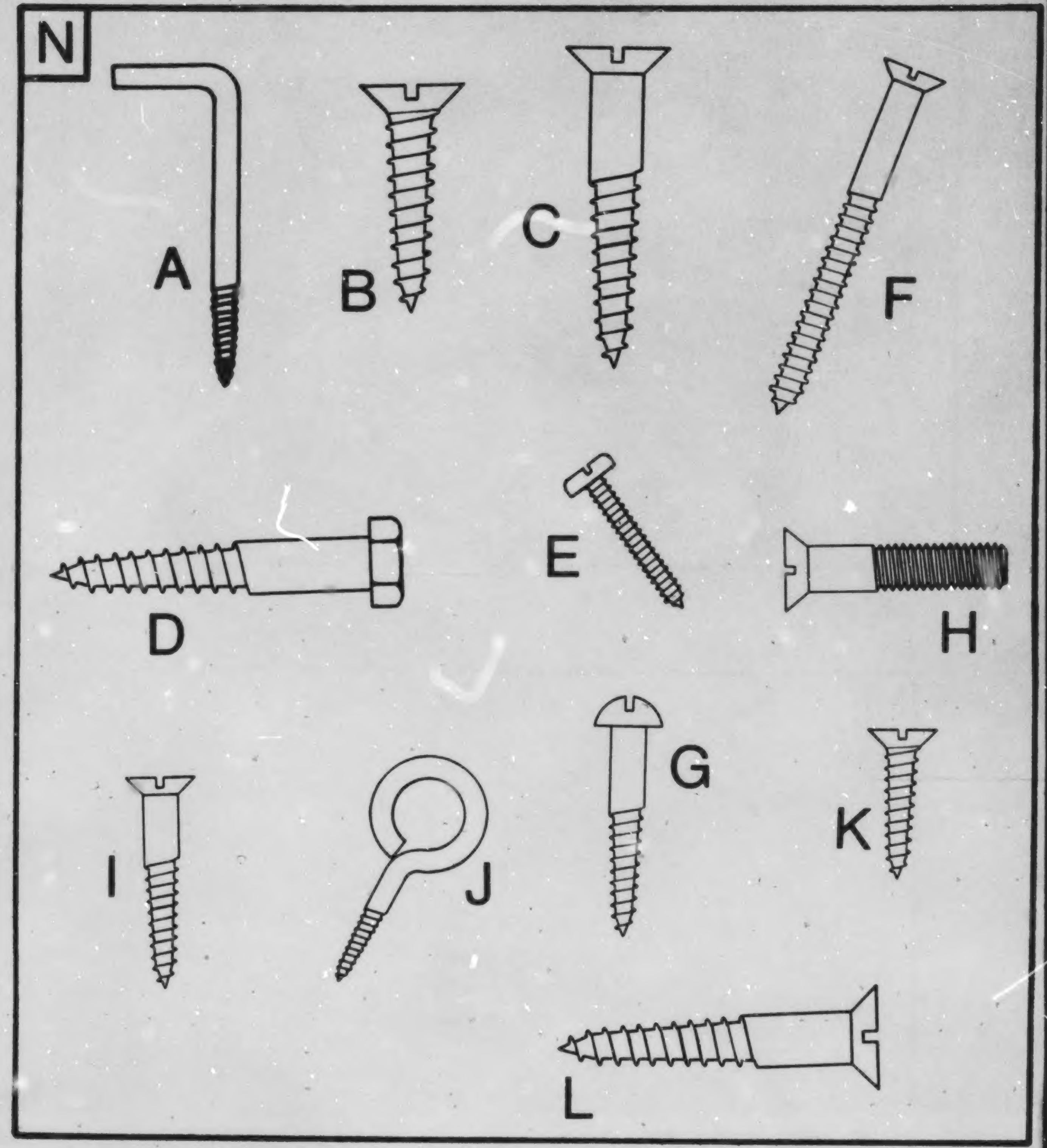
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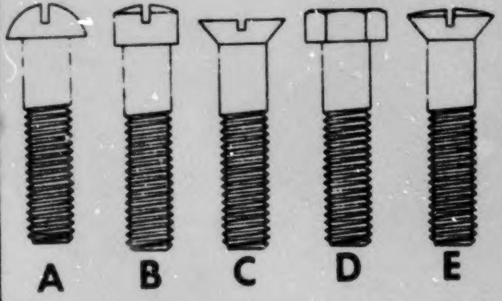
Summative Evaluation

Standard Flat Head Wood Screw

1 CIRCLE THE FILLISTER HEAD CAP SCREW.



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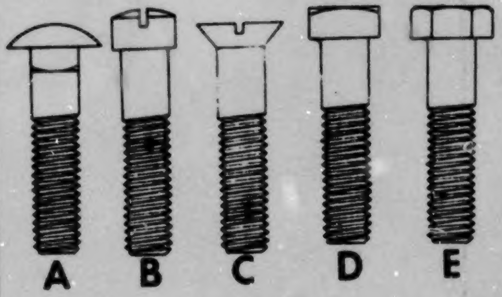

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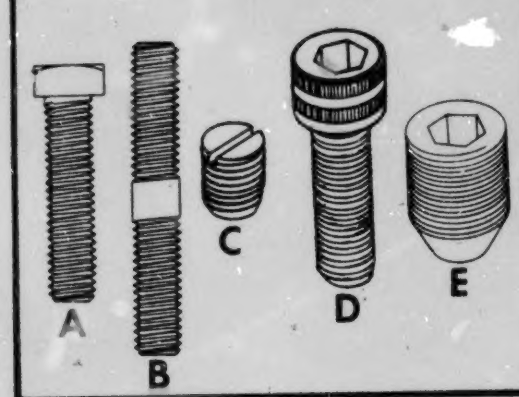

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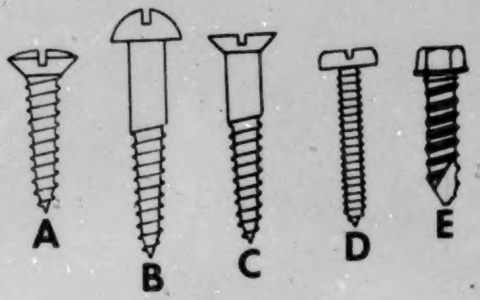

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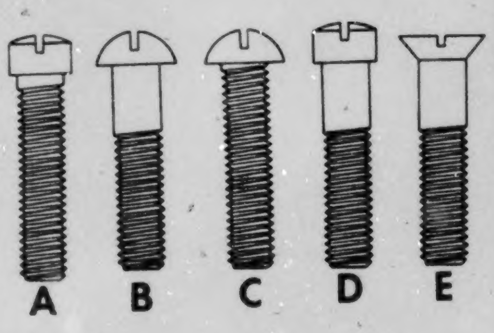

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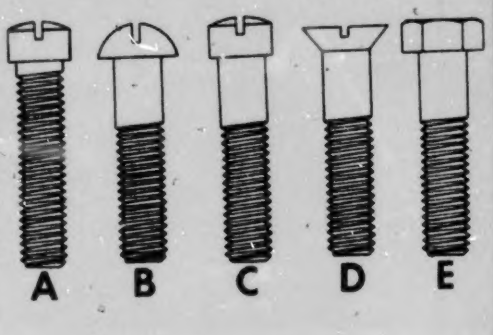

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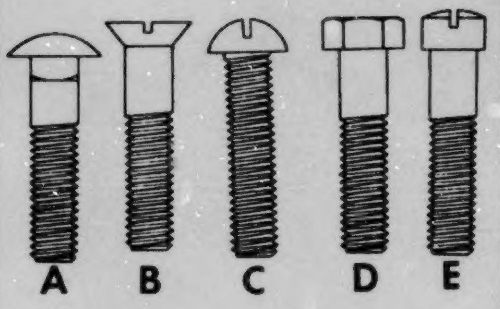

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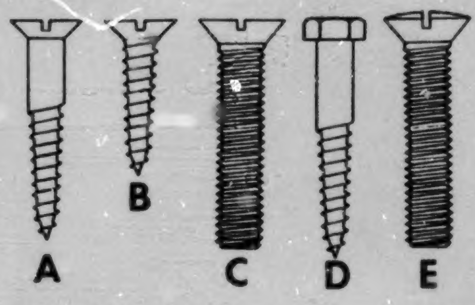

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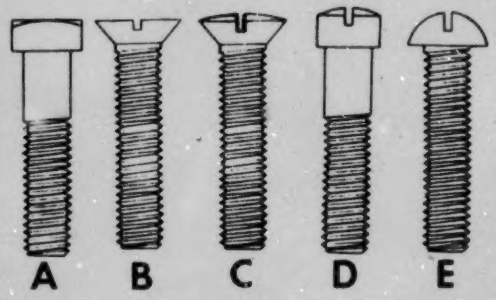

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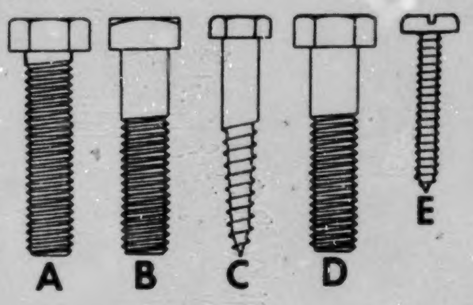

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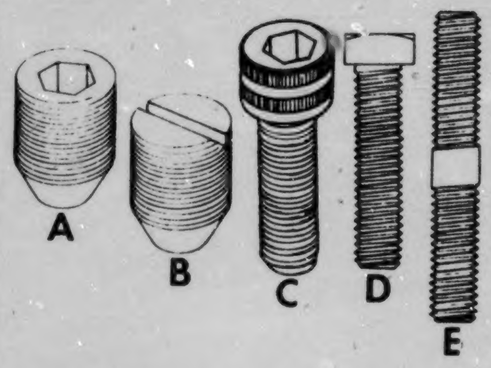

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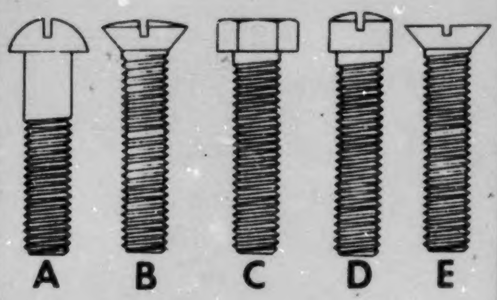
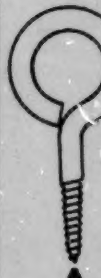


12A CIRCLE THE FLAT HEAD WOOD SCREW.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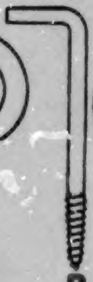
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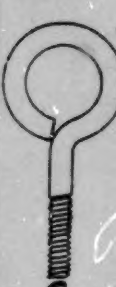
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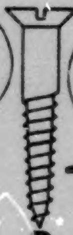
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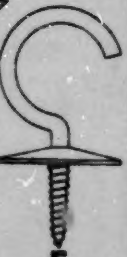
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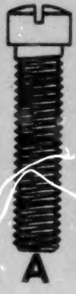
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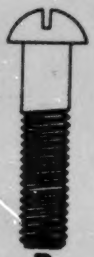
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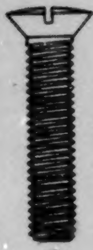
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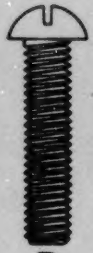
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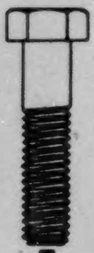
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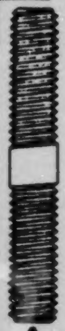
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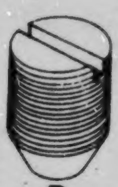
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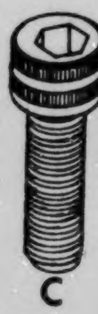
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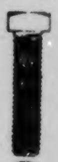
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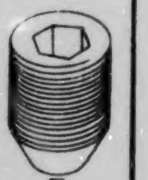
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Instructional Materials with Formative Evaluation

Safety Valve Symbol

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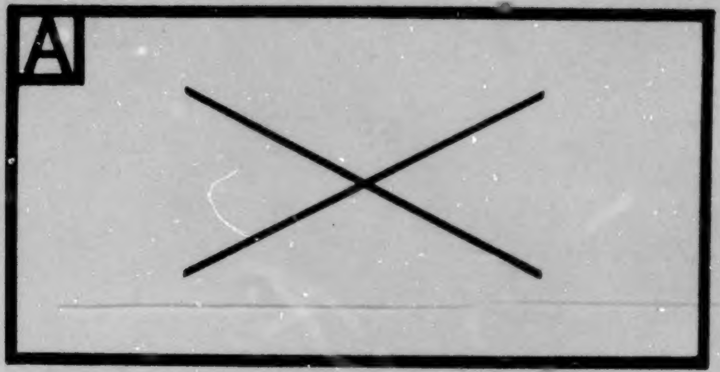
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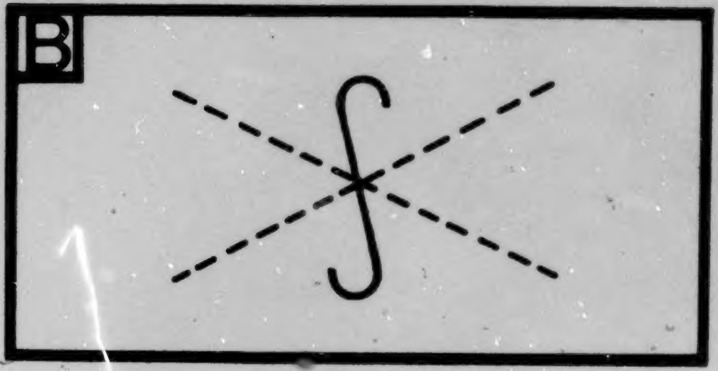
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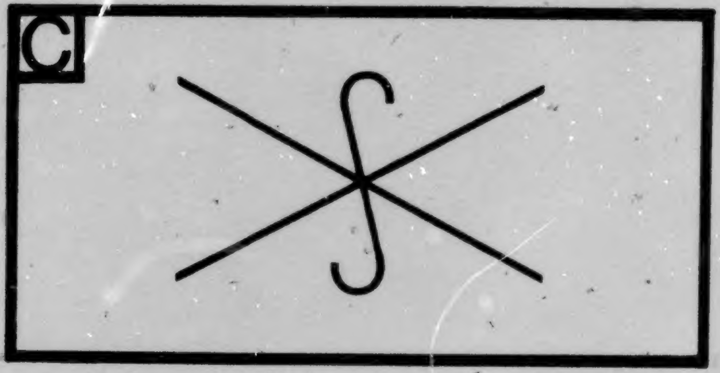
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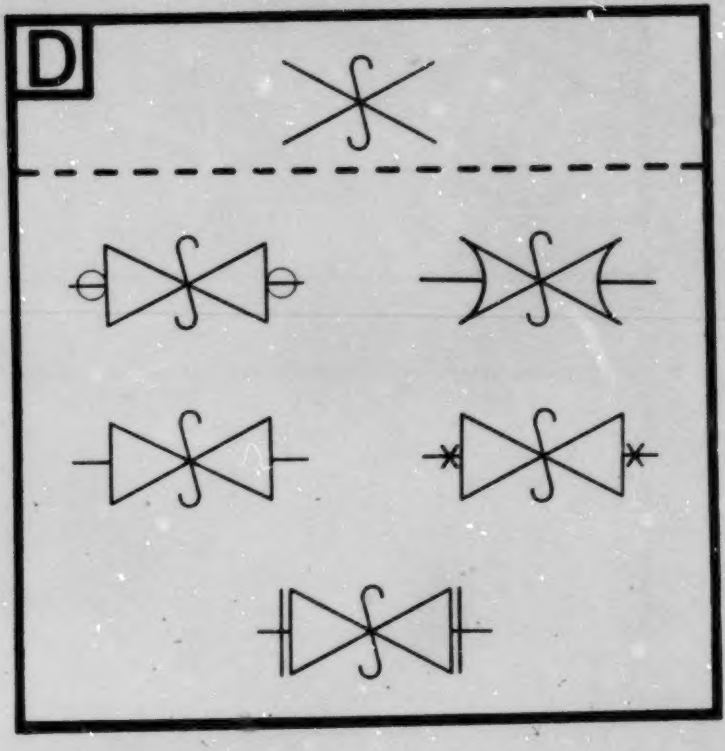

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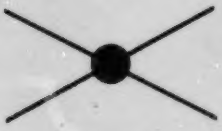

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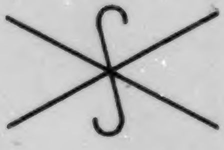

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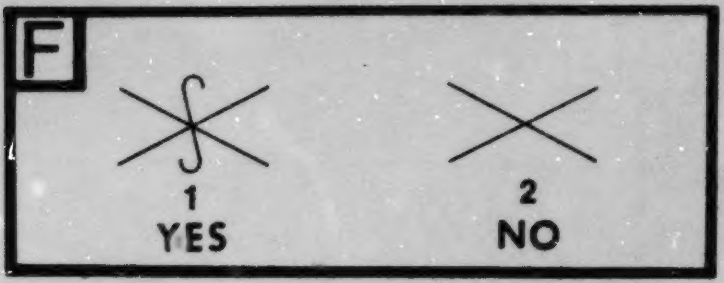
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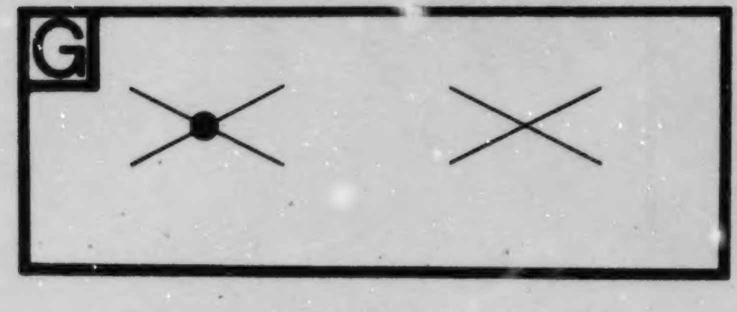
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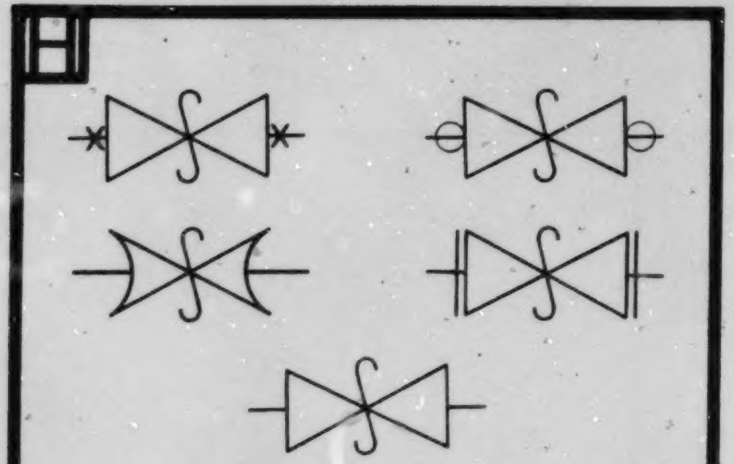
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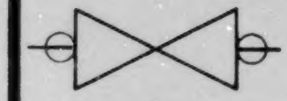
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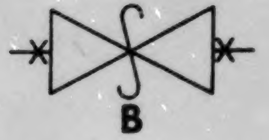
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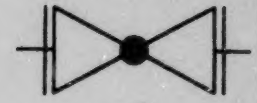
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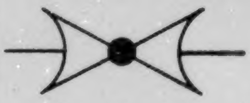
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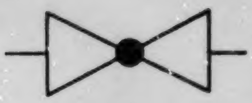
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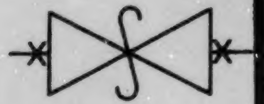
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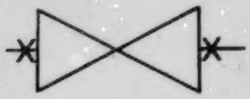
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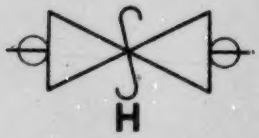
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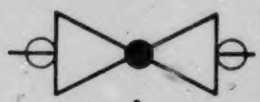
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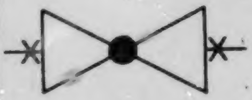
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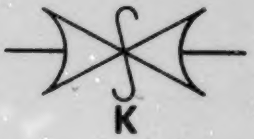
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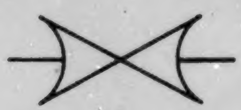
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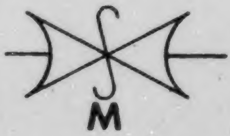
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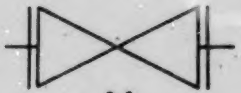
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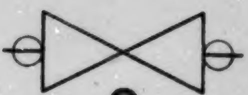
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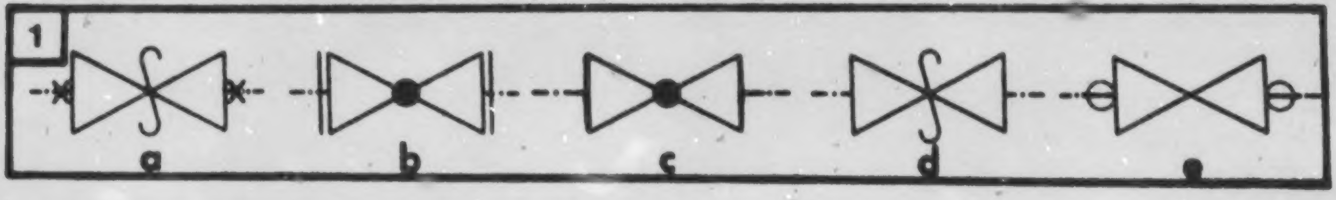
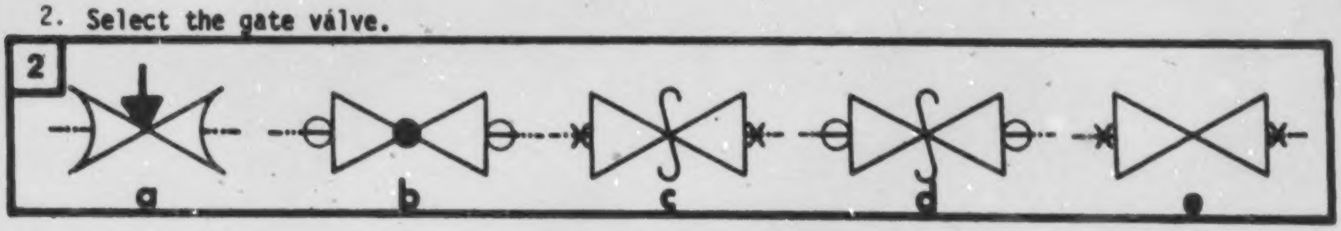
Summative Evaluation

Safety Valve Symbol

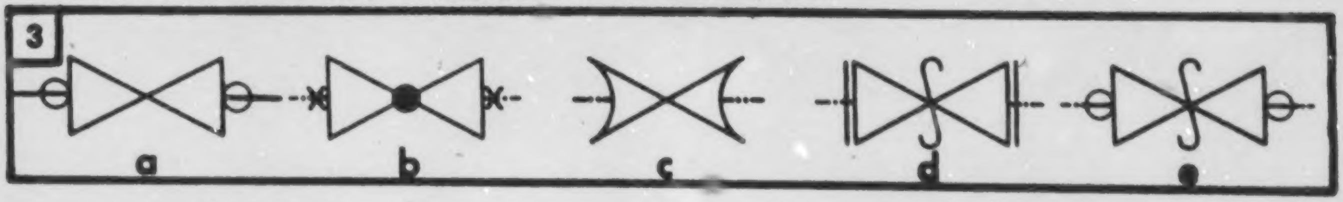
1. Select the valve connected to pipes by soldered joints.



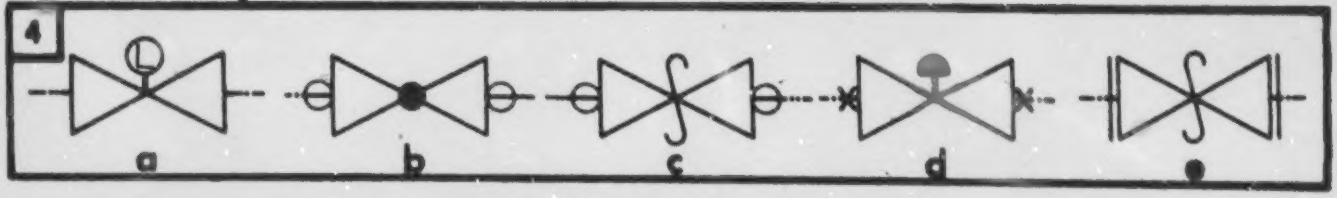
2. Select the gate valve.



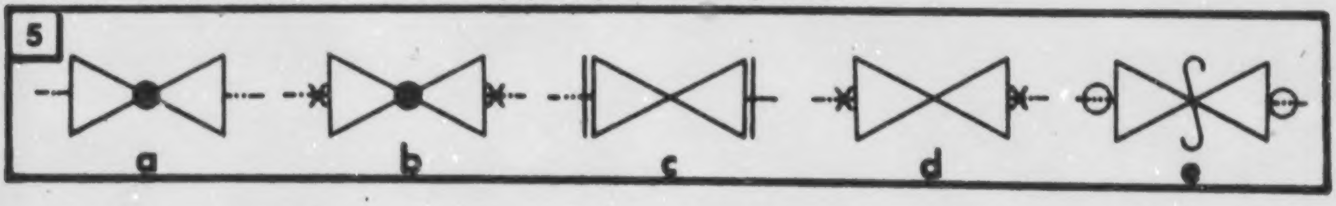
3. Select the valve that is connected to hot water pipes.



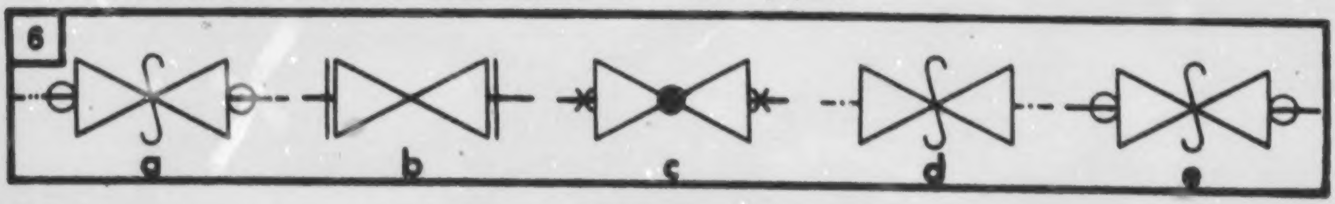
4. Select the globe valve.



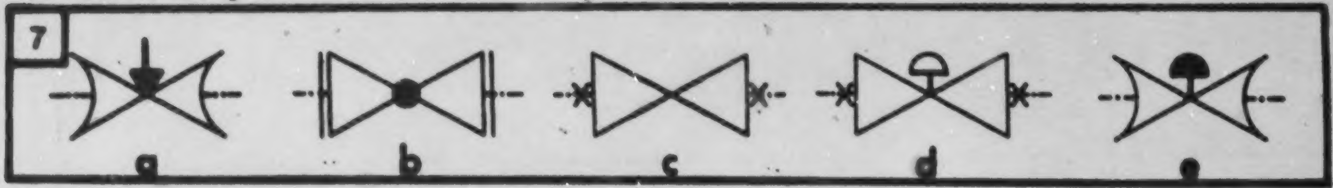
5. Select the valve connected to pipes by soldered joints.



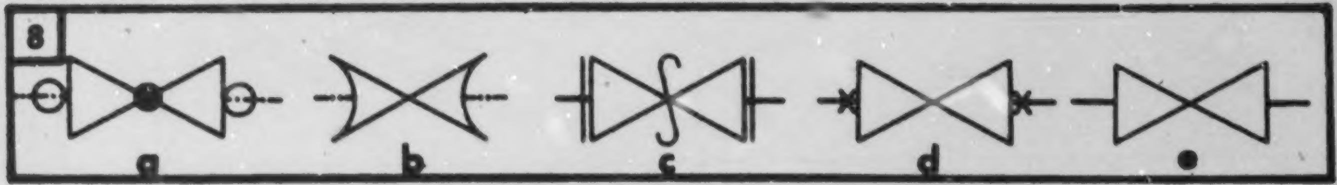
6. Select the valve that is connected to cold water pipes.



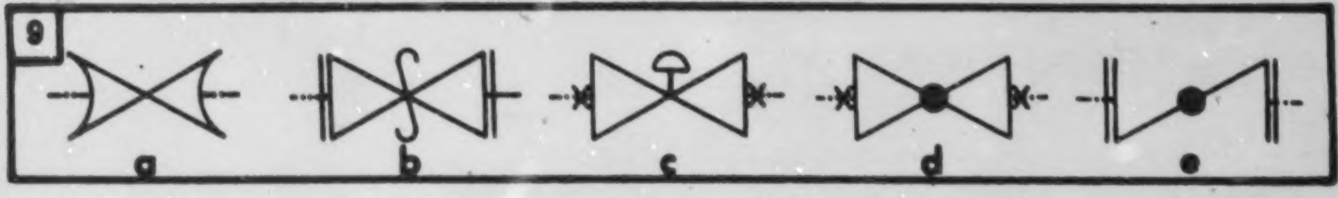
7. Select the globe valve.



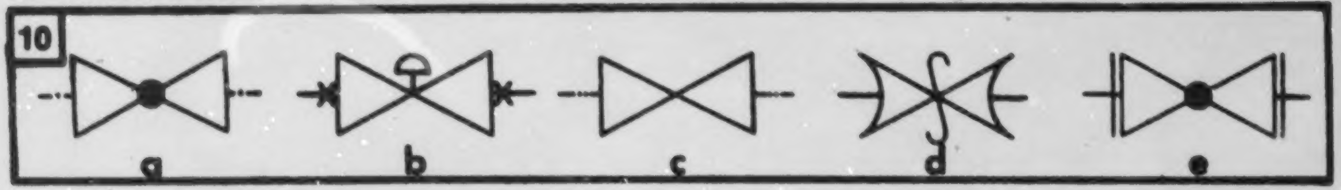
8. Select the valve that is connected to hot water pipes.



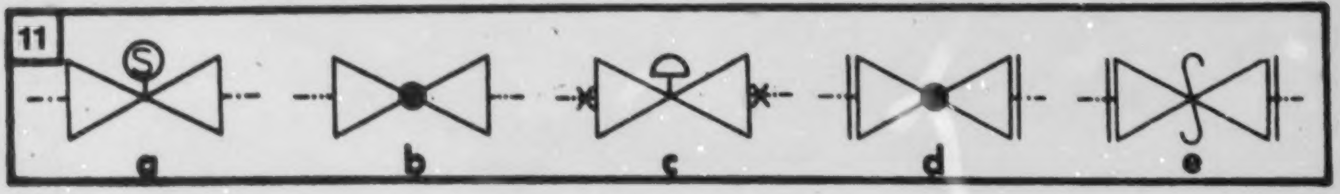
9. Select the safety valve.



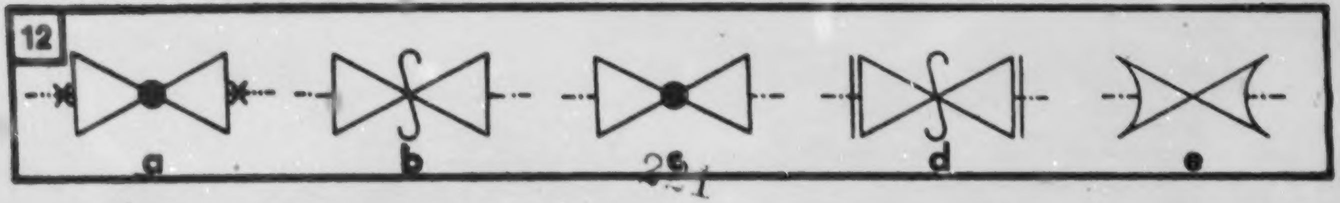
10. Select the valve that is connected to cold water pipes.



11. Select the safety valve.

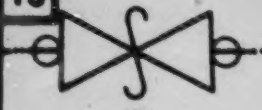


12. Select the valve connected to pipes by welded joints.



13. Select the valve that is connected to pipes by soldered joints.

13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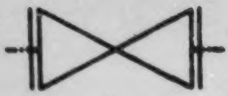
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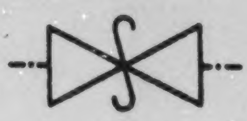
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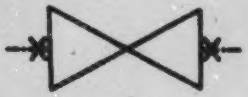
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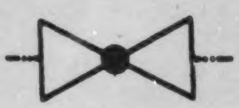
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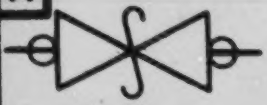
14. Select the valve that is connected to pipes by threaded joints.

14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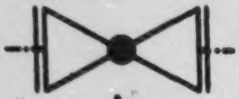
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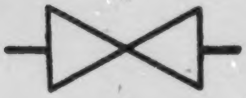
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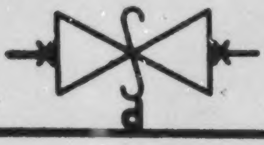
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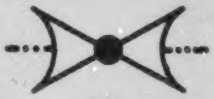
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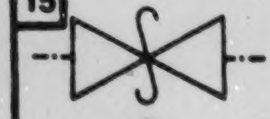
15. Select the globe valve.

15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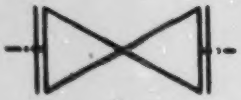
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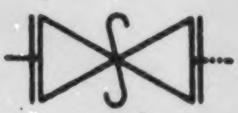
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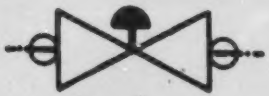
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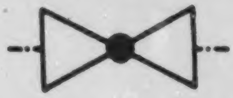
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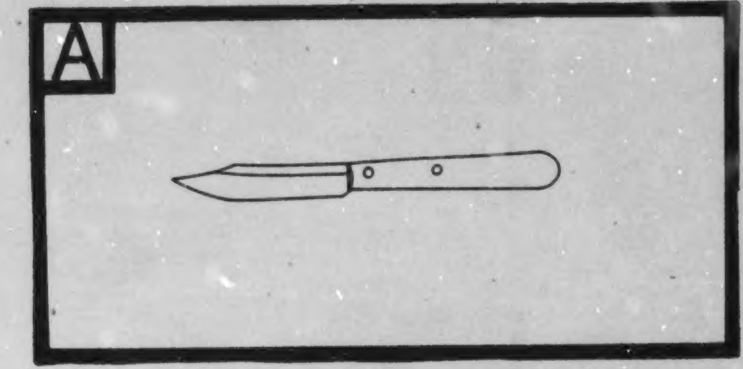
Instructional Materials with Formative Evaluation

Paring Knife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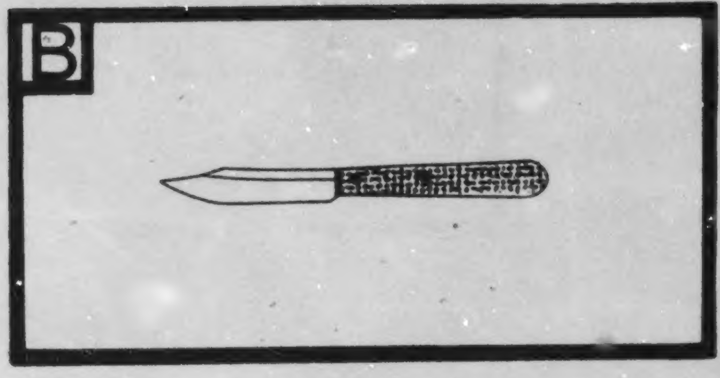
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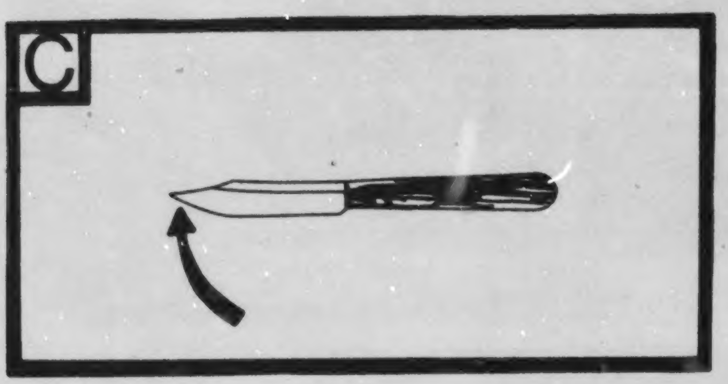
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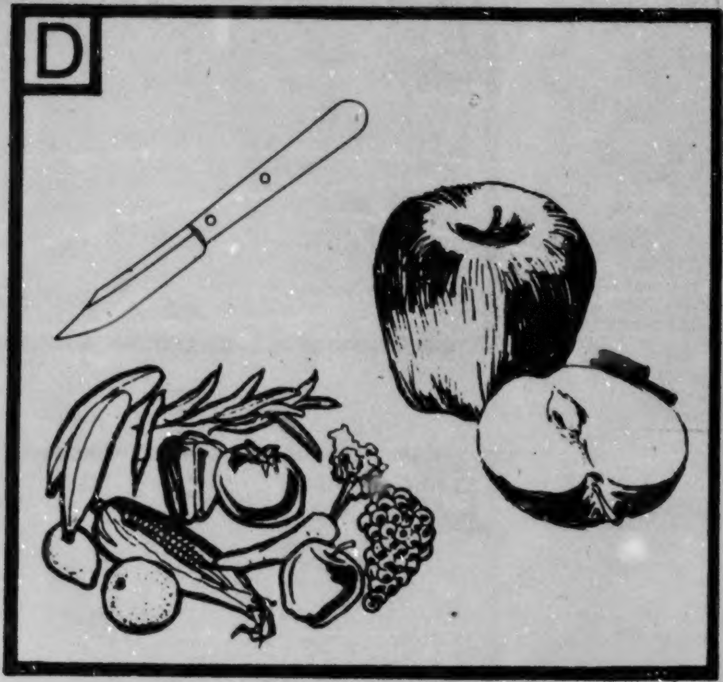
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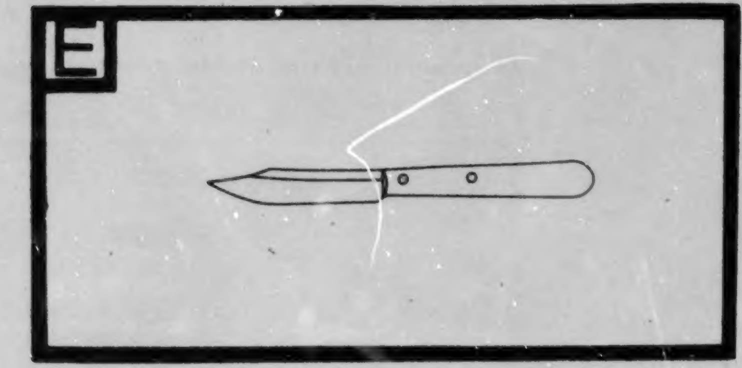
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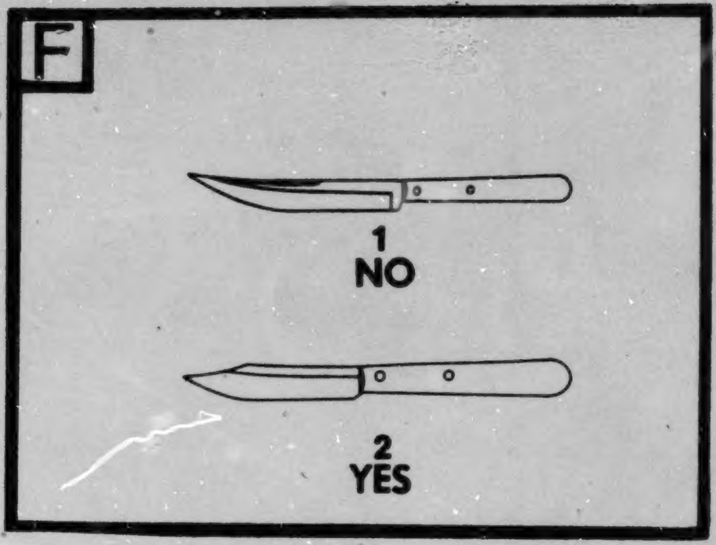
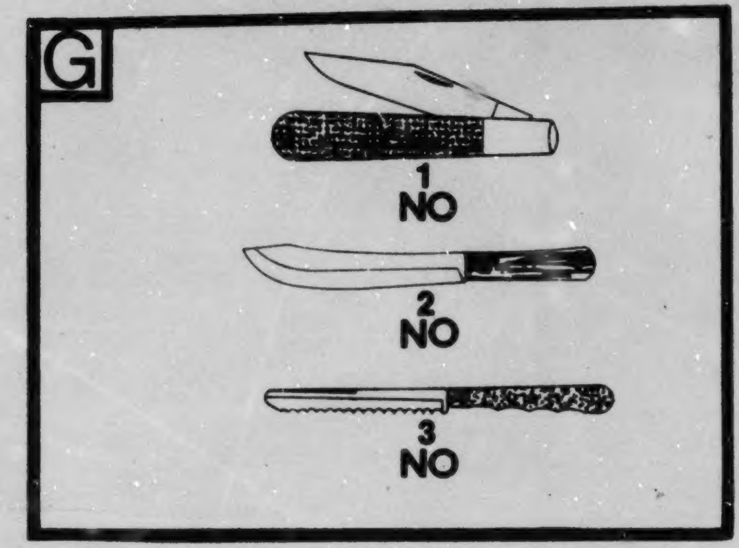

F
1
NO
2
YES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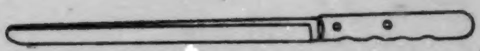
1
NO
2
NO
3
NO

Review 5



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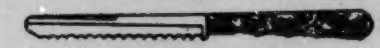

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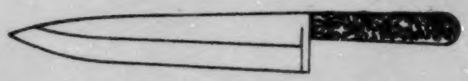

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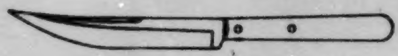

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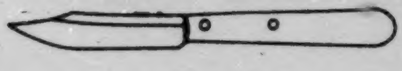

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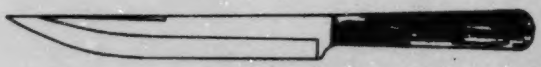

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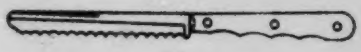

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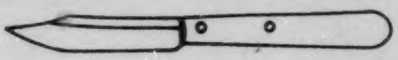

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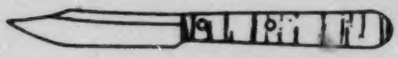
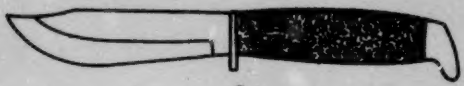


I

Summative Evaluation

Paring Knife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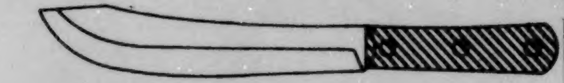
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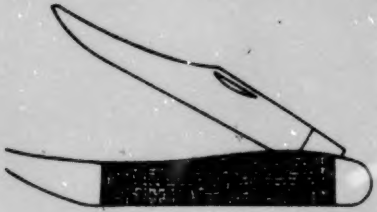
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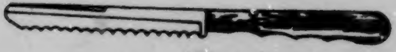
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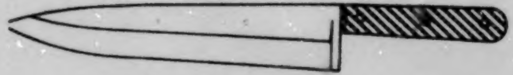
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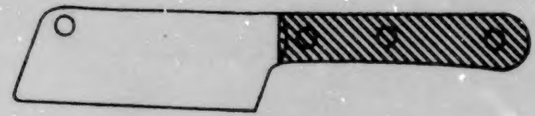
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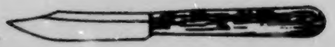

G

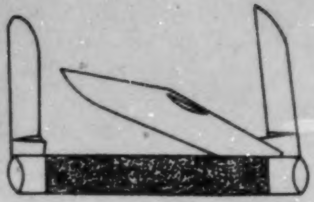
1. To chop some thick pieces of meat, which knife should you use?

2. To cut up a fish which knife should a cook use?

3. Which knife is a paring knife?

4. To peel or slice a lemon, which knife should be used?

5. If you were hunting in the woods which knife would you use the most?



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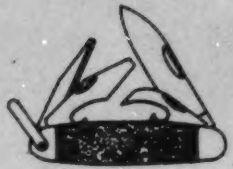

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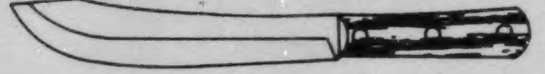

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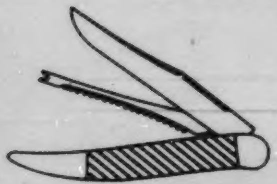

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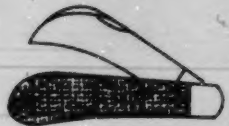

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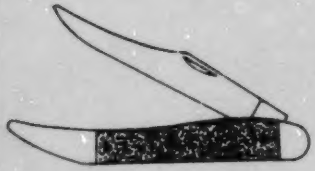

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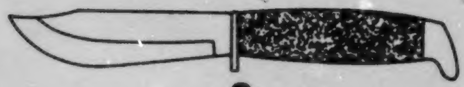


G

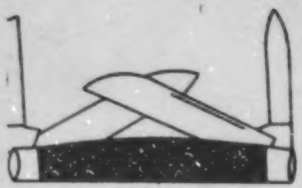
6. Which knife should you use to re-shape a fish hook?

7. Which knife should be used to skin a rabbit?

8. Which knife is a fish knife?

9. If you must open a can of orange juice, which knife should you use?

10. Trimming the branches from bushes or shrubbery should be done with which type of knife?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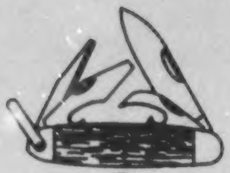
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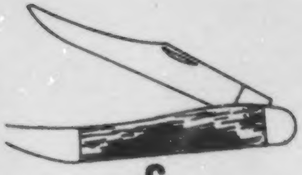
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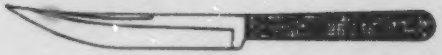
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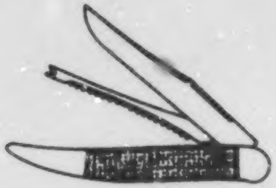
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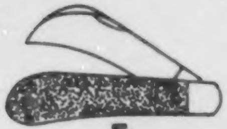
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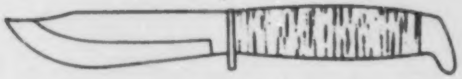

G

11. Which knife is a pruning knife?

12. Which knife should you take when going hunting?

13. If you were a gardener, which knife should you keep in your tool box?

14. Which knife should you use to shape a rose bush?

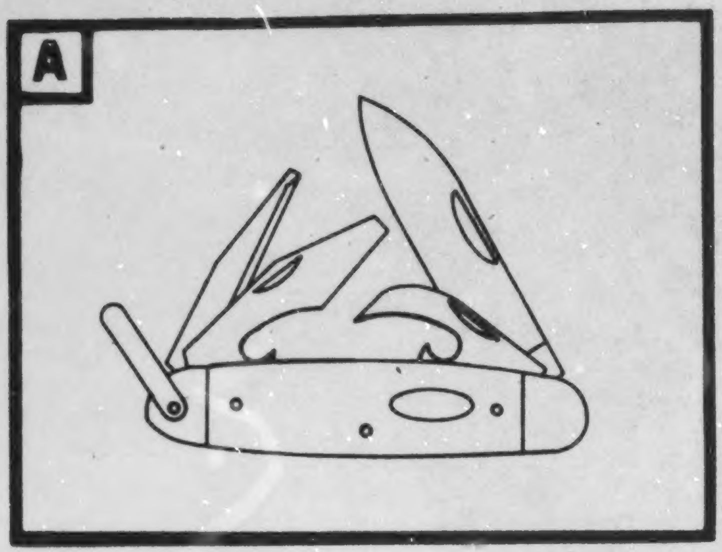
15. Which knife should be used to skin a deer?

Instructional Materials Without
Concept Teaching Format

Common Knives

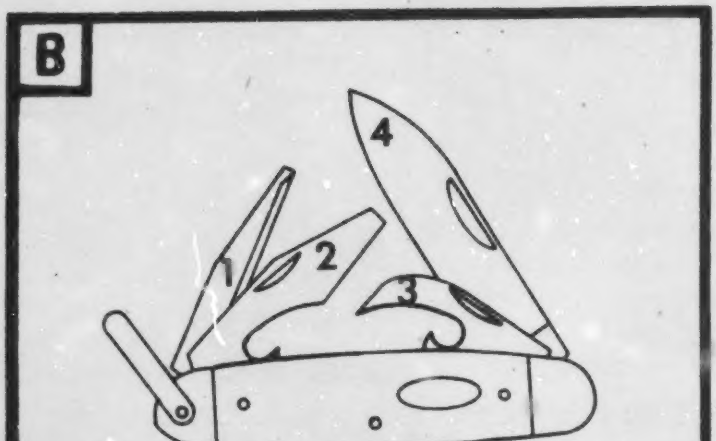
The Utility Knife

In box A you will see a utility knife.



You can see that the utility knife has 4 different blades.

In box B you can see that each blade has a different number.



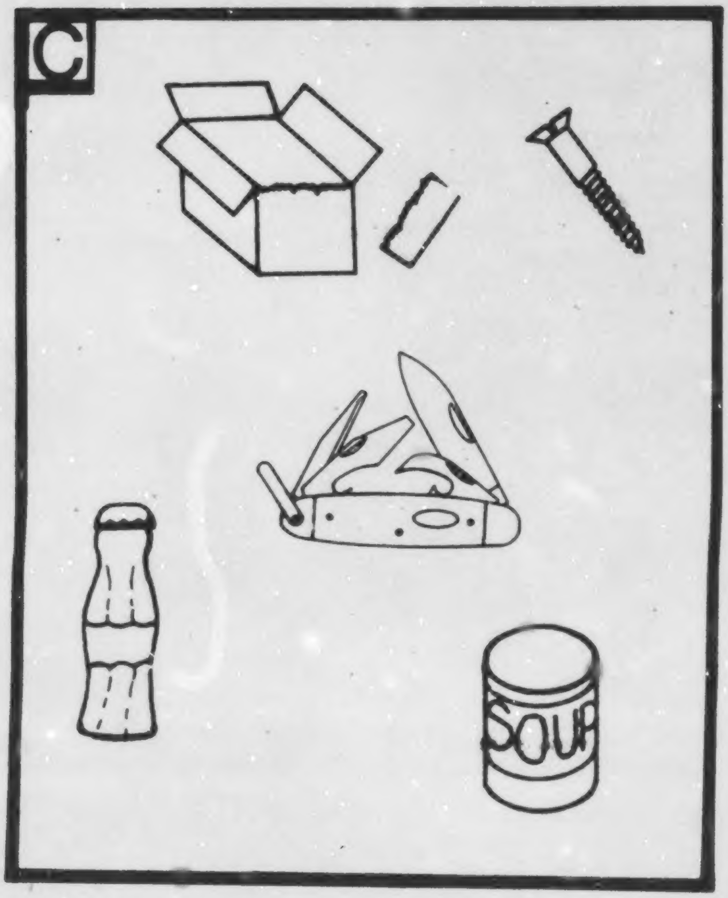
Blade #1 is used for cutting curved outlines, for scraping materials, and for certain types of whittling.

Blade #2 can be used as a bottle opener and also like a screwdriver.

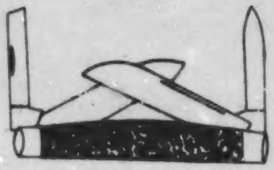
Blade #3 is used for opening cans or can be used to punch holes in certain objects.

Blade #4 can be used to cut just about any material that is softer than the blade itself.

Look at box C and you will notice several things that should be cut, opened, or fixed with a utility knife.



Review 1



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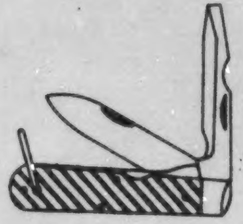

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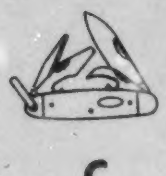

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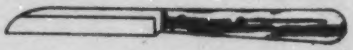

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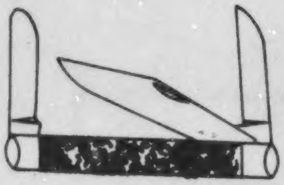

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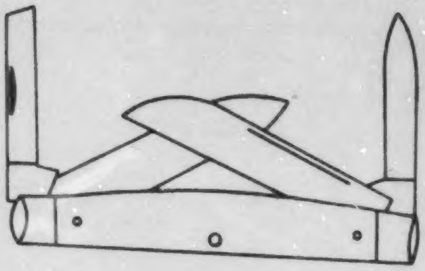

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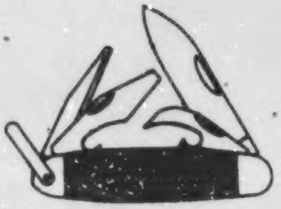

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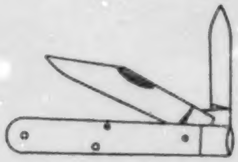

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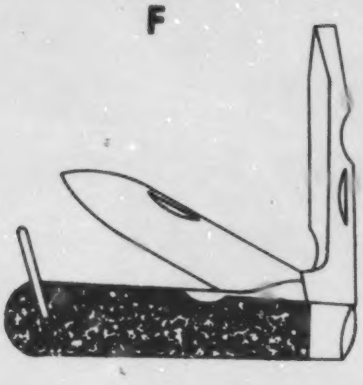
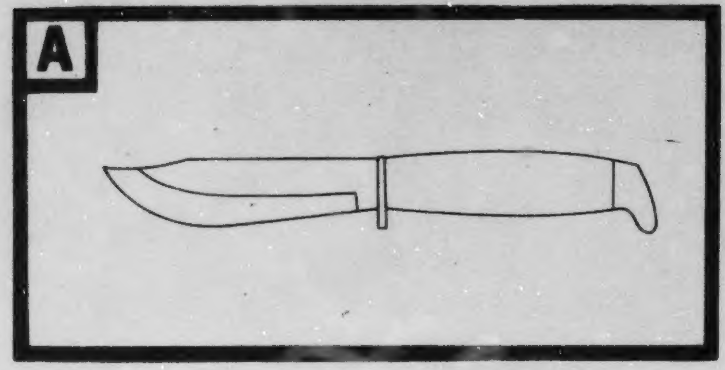


I

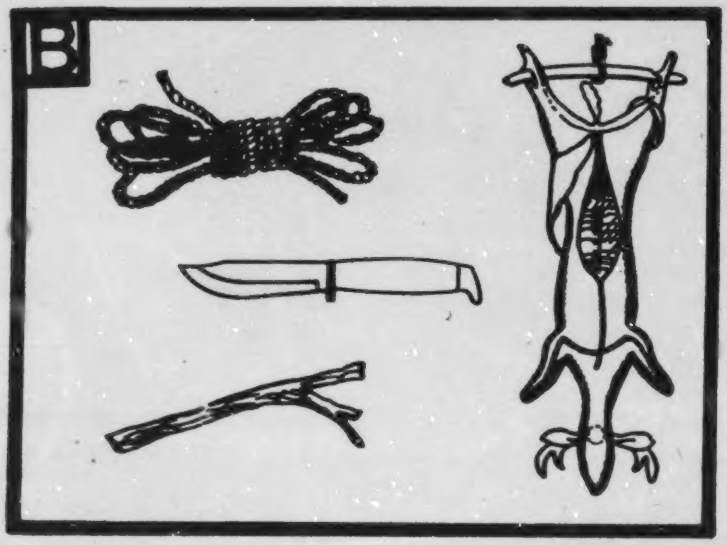
The Hunting Knife

The knife shown in box A is called a hunting knife.

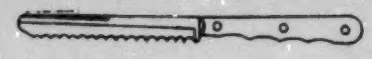


The hunting knife can be used to cut rope, to cut branches, and to skin an animal.

In box B you can see some of the things that should be cut by using a hunting knife.



Review 2



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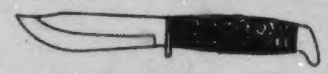

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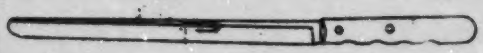

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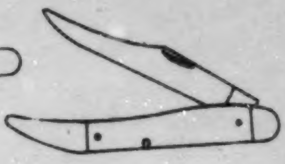

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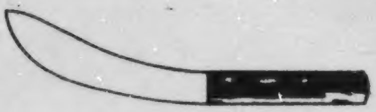

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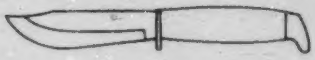

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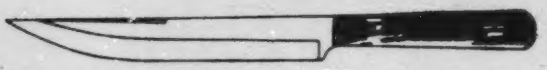

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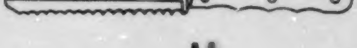

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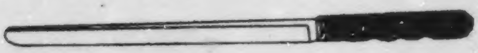
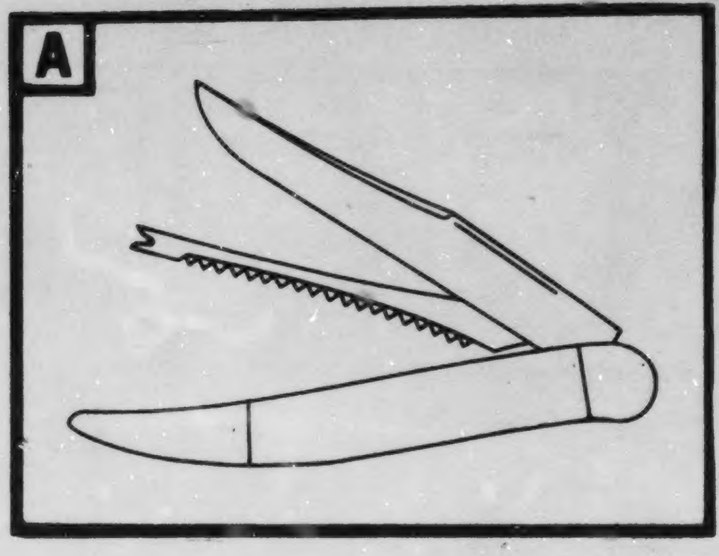


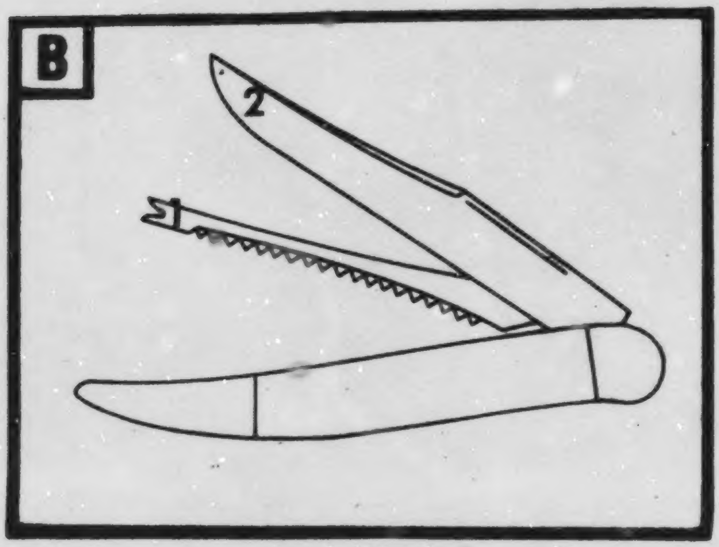
I

The Fish Knife.

In box A you will see a fish knife.



You can see that the fish knife has two different blades. In box B you can see that each blade has a different number.

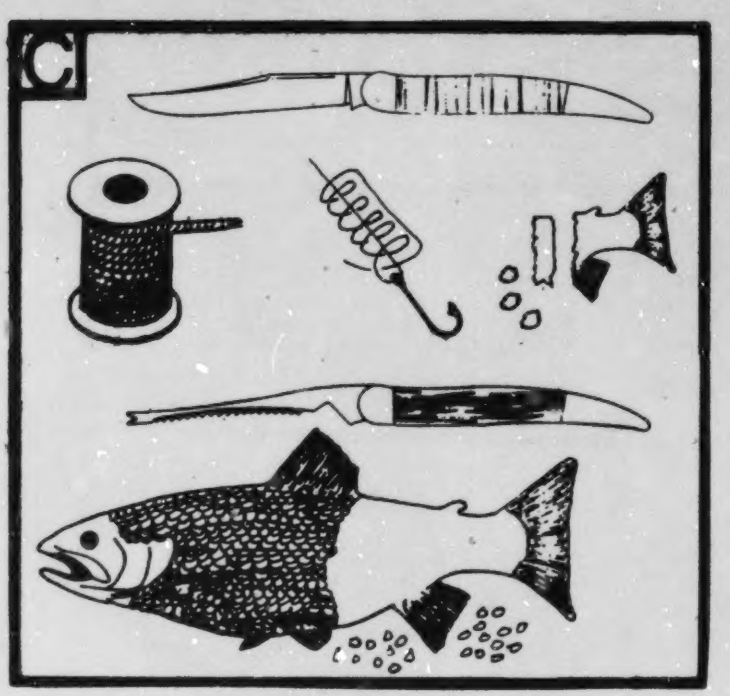


Blade #1 is called the scaler blade. This blade is used to clean fish by scraping off the scales. It is also used to help remove fish hooks.

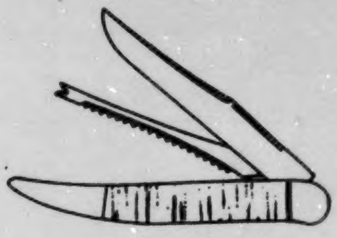
Blade #2 is called a clip blade and it can be used to cut fishing line, to cut cord for repairing fish nets, to cut materials used in making fish lures, or to cut up bait.

The handle of the fish knife is used to re-shape bent fish hooks.

In box C are pictures of some of the things that you would use a fish knife to cut.



Review 3



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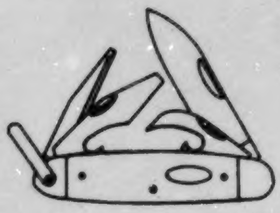

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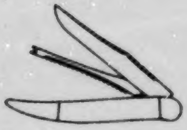

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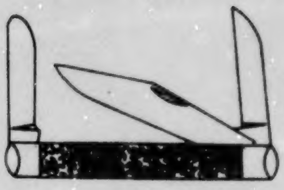

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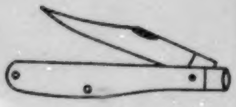

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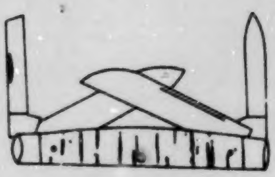

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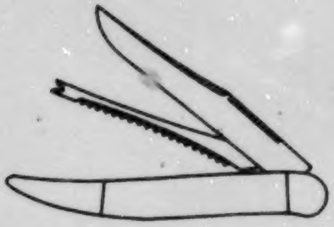

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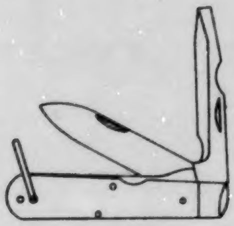

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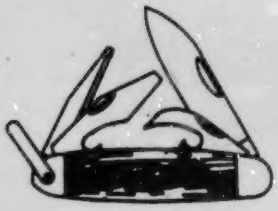
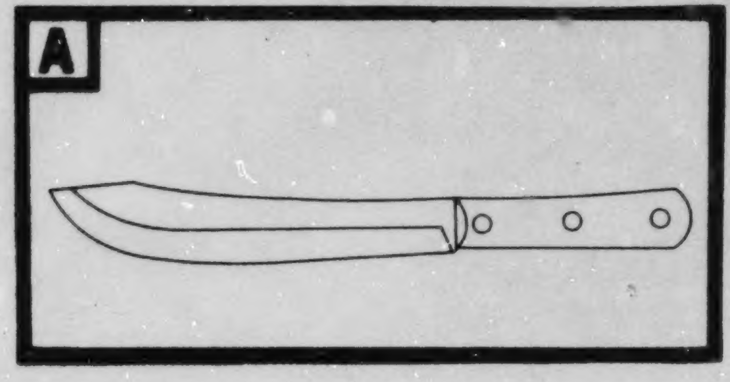


I

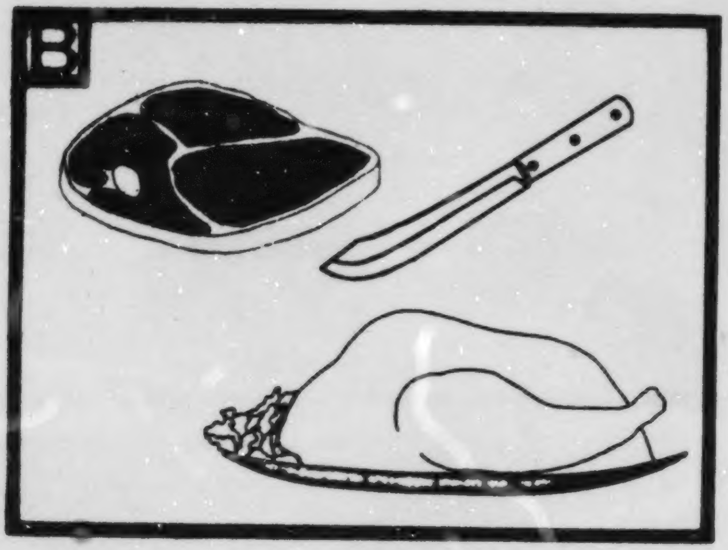
The Butcher Knife.

The knife shown in box A is called a butcher knife.



The butcher knife has several uses. It is used to cut, separate, and cube meat, before it is cooked. A butcher knife can also be used to cut up a chicken for frying or baking. Another use would be to cut and separate fish.

In box B are some of the things that should be cut with a butcher knife.



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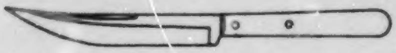
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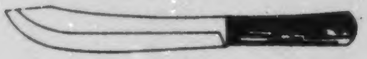
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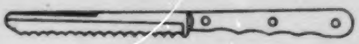
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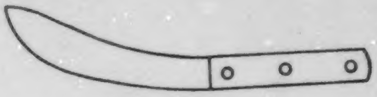
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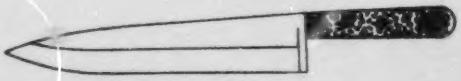
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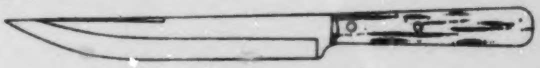
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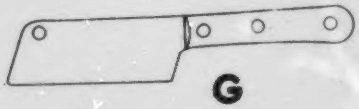
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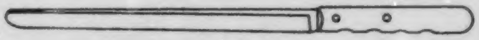
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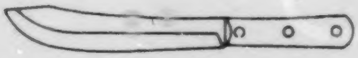
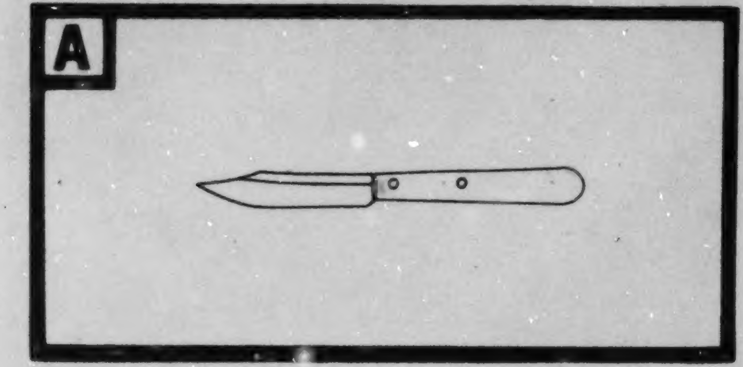

I

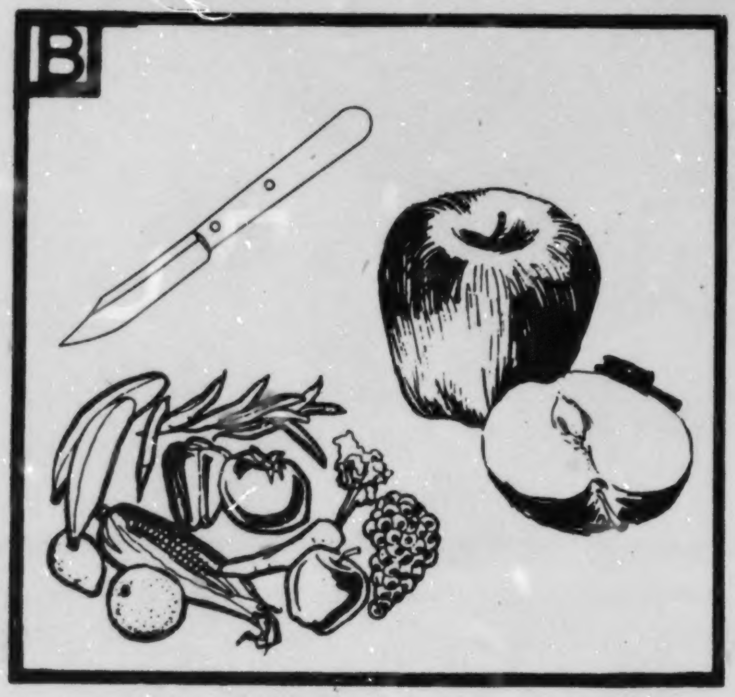
The Paring Knife

In box A you will see a paring knife.



A paring knife can be used to pare, peel, and slice fruits and vegetables.

Look at box B to see some of the fruits and vegetables that you should peel or slice with a paring knife.



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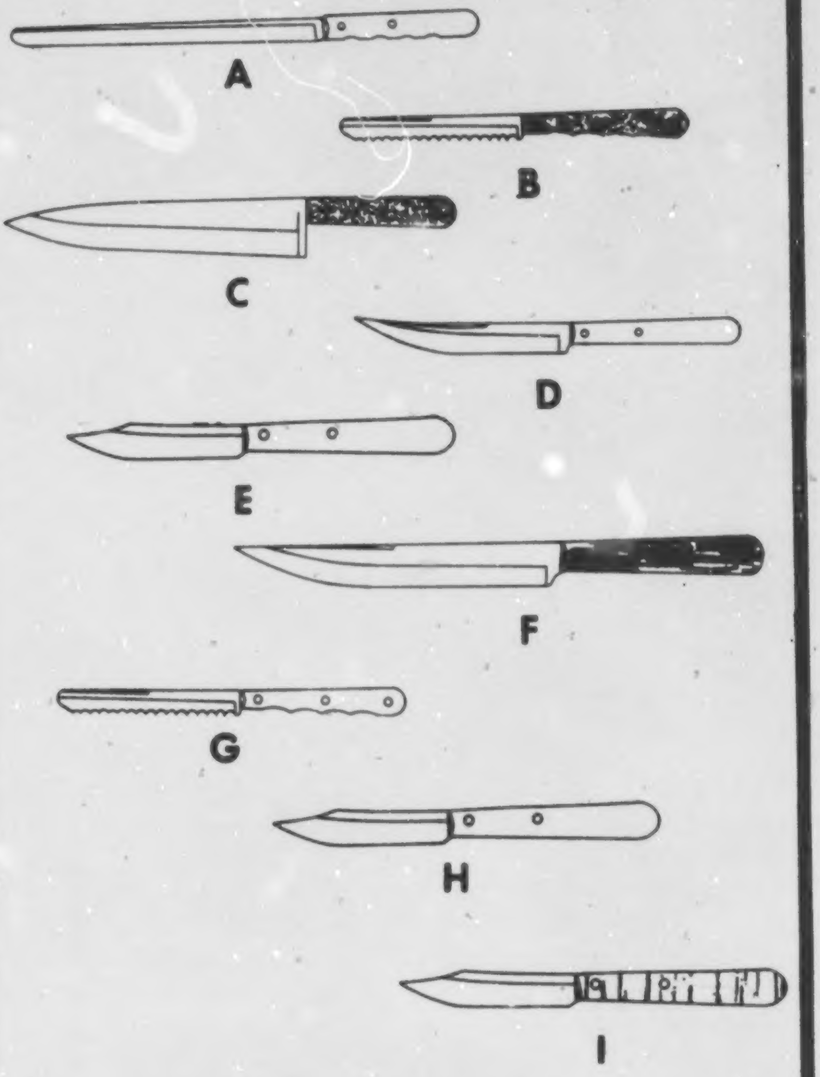
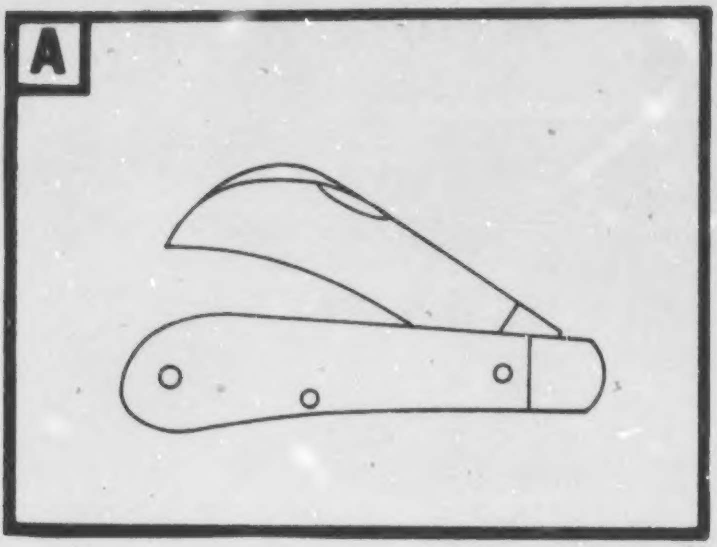


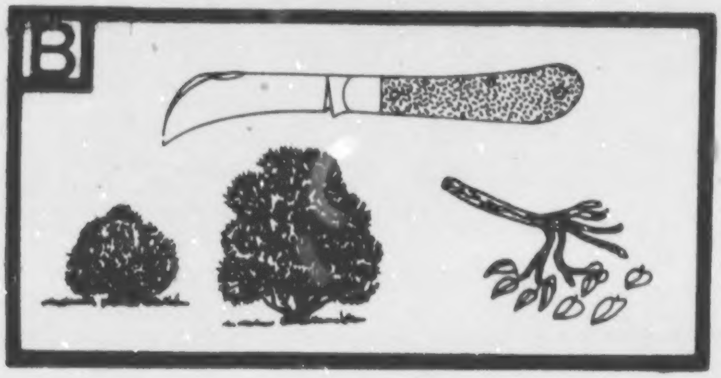
The Pruning Knife

The knife shown in box A is called a pruning knife.

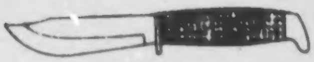


The pruning knife can be used to prune and trim shrubs and bushes. It can also be used to trim small branches and leaves on a tree.

In box B are examples of some of the things that should be cut and trimmed with a pruning knife.



Review 6



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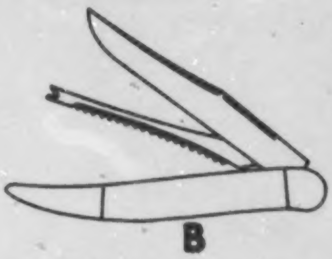

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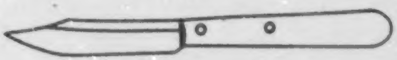

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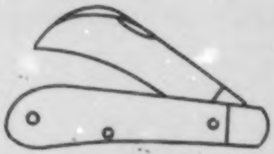

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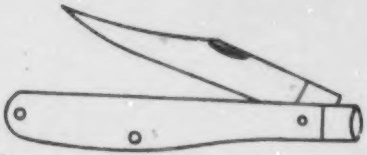

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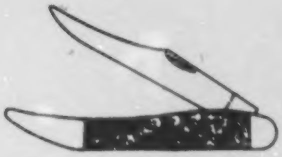

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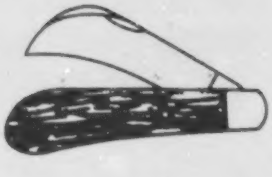

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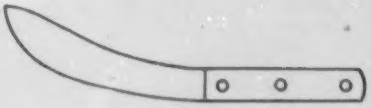
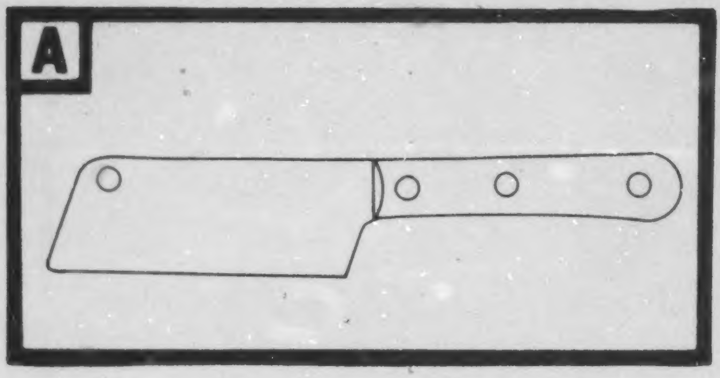


H

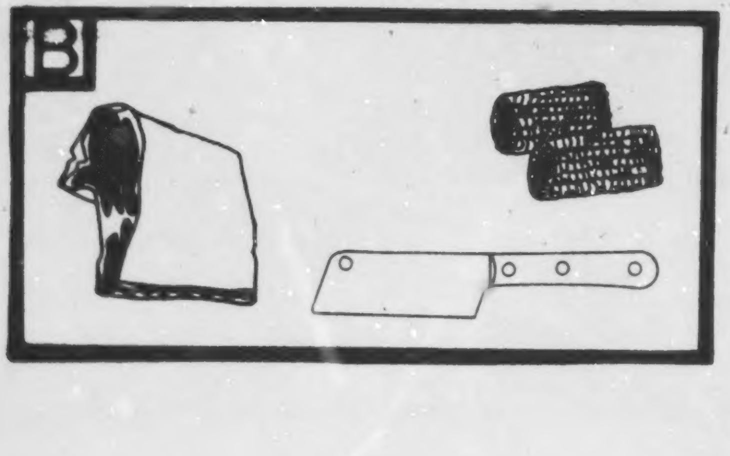
The Meat Cleaver

In box A you will see a meat cleaver.

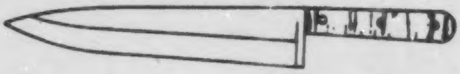


The meat cleaver is used to separate foods (such as meat with tough bone or muscle) with a forceful blow. Also, foods that have been frozen can be cut into smaller pieces with a meat cleaver.

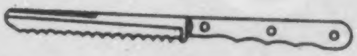
Examples of foods that should be cut with a meat cleaver are shown in box B.



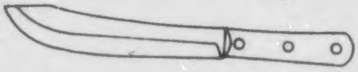
Review 7



A



B



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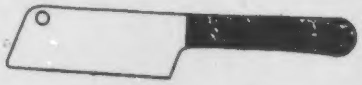

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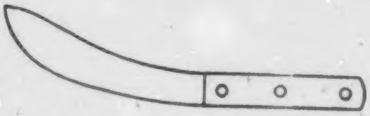

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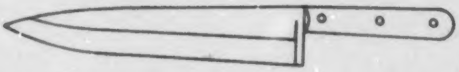

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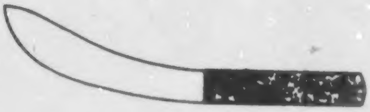

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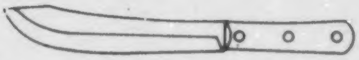

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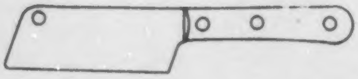


I

APPENDIX B

Scripts for Instructional Materials

i. Common Fasteners

ii. Plumbing Valve Symbols

iii. Common Knives

iv. Plumbing Valve Symbols with Verbal Cues

Scripts for Instructional Materials

Common Fasteners

Standard Flat Head Wood Screw

In Box A you can see a Standard Flat Head Wood Screw. To identify the Standard Flat Head Wood Screw you should look for: 1) a flat head with a staight slot, 2) a bearing surface that slants inward, 3) a part of the body with threads and a part with no threads, and 4) a pointed base. Any screw having these parts can be called a Standard Flat Head Wood Screw.

Now look at Box B. Notice here that the top surface of the Standard Flat Head Wood Screw is flat just like the name says, flat head wood screw.

If you look at Box C, you can see that the Standard Flat Head Wood Screw has a bearing surface that slants in toward the body.

In Box D you will observe that the Standard Flat Head Wood Screw has a pointed base.

Notice in Box E that part of the body just below the head has no threads.

In Box F we can see that the lower part of the body of the Standard Flat Head Wood Screw does have threads.

Now look at Box G. Here you can see that the Standard Flat Head Wood Screw can be long or short, can be narrow or wide, and can be different shades and colors. However, the Standard Flat Head Wood Screw will always have: 1) a straight slot through a flat head, 2) an inward sloping bearing surface, 3) a part of the body that is threaded and a part that is unthreaded, and 4) a pointed base.

Look not at Box H. Notice that the two screws shown here look much the same. They both have pointed bases and threaded and unthreaded parts of the body, but number 2 does not have a flat head nor does it have an inward sloping bearing surface. Therefore, it cannot be a Standard Flat Head Wood Screw.

In Box I we again see two screws that look much the same. They both have pointed bases and they both have threaded and unthreaded parts of the body, but number 3 does not have a sloping bearing surface, nor does it have a slot cut through the flat part of the head. Number 3 therefore, cannot be a Standard Flat Head Wood Screw.

Now observe the two screws in Box J. They, too, look alike in some ways. They both have flat heads with slots through them, sloping bearing surfaces, and unthreaded and threaded parts of the body. But notice that number 5 does not have a pointed base. Number 5 therefore, cannot be a Standard Flat Head Wood Screw.

Again, the screws shown in Box K look much the same. They both have pointed bases, theaded and unthreaded parts of the body, sloping bearing surfaces, and flat heads, but if you will look closely at number 8, you can see that it does not have a straight slot cut through the head. For this reason number 8 is not a Standard Flat Head Wood Screw. It is a Special Flat Head Wood Screw with a hillips recessed head.

Look at Box L. Can you tell why the screws shown here are not Standard Flat Head Wood Screws? Number 1 has no unthreaded portion of the body, number 2 does not have a sloping bearing surface or a slot cut through a flat head, number 3 does not have a straight slot cut through the head, number 4 does not have a pointed base, and number 5 does not have a flat head.

In Box M, you see several Standard Flat Head Wood Screws. Notice that each one has: 1) a straight slotted, flat head, 2) a sloping bearing surface, 3) a threaded and an unthreaded part of the body, and 4) a pointed base. These are all examples of the Standard Flat Head Wood Screw.

In Box N you can see different kinds of screws and bolts. With your pencil, encircle all of the ones that you think are Standard Flat Head Wood Screws. Then, on the line below the box write the letters of those you have circled. (Pause) You should have listed the letters: C, F, L, and I. If you have all four letters listed and no others you have a perfect score. If you missed some or marked down some that should not be there, look them over and see if you can tell why they are not Standard Flat Head Wood Screws.

Script for Fillister Head Cap Screw

Look now at Box A where you will see a Fillister Head Cap Screw. To tell the Fillister Head Cap Screw apart from other bolts and screws you should look for: 1) a cylindrical head that is slotted and slightly rounded on top, 2) a bearing surface that forms a right angle with the body, 3) threads that go part way or all the way up the body, and 4) a flat base.

In Box B, you can see that the top of the Fillister Head Cap Screw is slighty curved or rounded.

Observe in Box C that the head of the Fillister Head Cap Screw is cylindrical, or shaped like a drum.

Look now at Box D. Notice that the underside of the head called the bearing surface, is flat. We can say that the bearing surface forms a right angle with the body.

Look at Box E. Recall that the threads of the Fillister Head Cap Screw can either go part way up the body or all the way up the body to the head.

Now look at Box F. Here we can see that the Fillister Head Cap Screw can be long or short, wide or narrow. It can be made of black steel, bright steel, aluminum, bronze, copper or brass, and, therefore, can be different colors. However, it will always have: 1) a cylindrical head that is slotted and rounded on top, 2) a bearing surface on the underside of the head that forms a right angle with the body, 3) threads that go part way or all the way up to the head, and 4) a flat base.

Turn now to Box G. Can you tell that numbers 1 and 2 are somewhat the same? Notice that they both have flat bases; they both are threaded the full length of the body; they both have slots in the head. Number 1 has a bearing surface that forms a right angle with the body, but number 2 has a bearing surface that is not at right angles with the body, nor is the head on number 2 dome-shaped or slightly rounded. Because of this number 2 is not a Fillister Head Cap Screw.

Now look at Box H. Both screws look much the same: they both have flat bases; they are both threaded for the full length of the body; the bearing surface of each is at right angles to the body. However, number 3 does not have a cylindrical head nor is the head slotted. So number 3 cannot be a Fillister Head Cap Screw.

Glance at Box I. These two screws are also somewhat the same. Observe that: they both have flat bases; they both have threaded parts and unthreaded parts of the body; they both have a bearing surface that forms a right angle with the body; they both have slots in the heads; the tops of both heads are rounded. However, the head of number 6 is not cylindrical like a drum, so number 6 cannot be a Fillister Head Cap Screw.

Look now at the screws in Box J. None of them is a Fillister Head Cap Screw. Number 1 has a flat top on the head, and the head is not cylindrical. Number 2 does not have a cylindrical head, and number 3 has a bearing surface that does not form a right angle with the body. Each of these screws has a part that tells us it is not a Fillister Head Cap Screw.

The screws shown in Box K all have: 1) a flat base, 2) threads which go part way or all the way up the body, 3) a bearing surface which forms a right angle with the body, and 4) a cylindrical or drum-shaped head which is slightly rounded on top and slotted. Each example in Box K has all of the parts that a Fillister Head Cap Screw should have.

In Box L you can see different kinds of bolts and screws. With your pencil, encircle all of the ones you think are Fillister Head Cap Screws. Then on the line below the box, write the letters of all those you encircled. (READER: 45 second pause.) See if you have written these letters: B, D, & G. If you have all three listed and no others, you get a perfect score. If you missed some or put some down that are not Fillister Head Cap Screws, look over the ones you missed and see if you can tell why they are not Fillister Head Cap Screws.

Script for Round Head Machine Screw

Look at Box A where you will see a Round Head Machine Screw. To tell the Round Head Machine Screw apart from other screws and bolts, you should look for: 1) a head that is slotted and rounded on top, 2) a bearing surface that forms a right angle with the body, 3) threads that go nearly all the way up the body, and 4) a flat base.

In Box B you can see that the top of the Round Head Machine Screw is rounded.

Observe in Box C that the head of the Round Head Machine Screw can have either a slot cut through the head, or a cross shaped recess cut into the head.

Look now at Box D. Notice that the underside of the head which we call the bearing surface is flat, and forms a right angle with the body.

The figure in Box E shows that the base of the body is flat.

Look now at Box F. Can you see that the threads of the Round Head Machine Screw go nearly all the way up the body to the head?

Notice in Box G that the Round Head Machine Screw can be long or short, wide or narrow. It can be made of bright steel, aluminum, bronze, copper or brass, and can therefore be of different colors. However, it will always have: 1) a round head that is slotted and rounded on top, 2) a bearing surface on the underside of the head that forms a right angle with the body, 3) threads that go nearly all the way up to the head, and 4) a flat base.

Turn now to Box H. Can you see that numbers 1 and 2 are somewhat the same? Notice that they both have flat bases; they both are threaded nearly the full length of the body; they both have bearing surfaces that form right angles with the body. Number 1 has flat sides around the head and no slot. Because of this, number 1 is not a Round Head Machine Screw.

Now look at Box I. Both screws look much the same: they both have flat bases; they both have round slotted heads; the bearing surfaces of both form a right angle with the body. However, number 4 is threaded only part way up the body and for this reason, cannot be a Round Head Machine Screw.

The screws shown in Box J have some parts in common also: they both have flat bases; they both have bearing surfaces which form right angles with the body; and both heads are rounded. However, there are some differences; the threads on number 6 do not go nearly to the top of the body. Furthermore, there is no slot in the head and it has a square neck. Number 6, therefore, cannot be a Round Head Machine Screw.

Box K also shows two screws which look much the same: both have threaded bodies; both have bearing surfaces which form right angles with the body; both have slots in the heads; and the tops of both heads are rounded. However, the base of number 8 is not flat, so number 8 cannot be a Round Head Machine Screw.

Look now at the screws in Box L. Can you see that none of them is a Round Head Machine Screw? Number 1 does not have threads which go nearly to the head; the bearing surface of number 2 does not form a right angle with the body; number 3 has a pointed base; number 4 has a cylindrical head; number 5 has no slot in the head. Each of these screws has something that tells us why it should not be called a Round Head Machine Screw.

Look at Box M. The screws shown here are all Round Head Machine Screws because they all have: 1) a flat base, 2) a body which is threaded nearly to the head, 3) a bearing surface which forms a right angle with the body, and 4) rounded heads that are slotted. Each example in Box M has all of the parts that a Round Head Machine Screw should have.

In Box N you can see different kinds of bolts and screws. With your pencil, encircle all those which you think are Round Head Machine Screws. Then write on the line below the box, the letters of all those you encircled. (READER: 45 second pause.) See if you have written these letters; D, F, H, I, & K. If you have all five listed and no others, you get a perfect score. If you missed some or put some down that are not Round Head Machine Screws, look over the ones you missed and see if you can tell why they are not Round Head Machine Screw.

Script for Hexagon Socket Set Screw

Look not at Box A. Here you will see a Hexagon Socket Set Screw. To tell the Hexagon Socket Set Screw apart from other bolts and screws look for: 1) a cylindrical, threaded boy, 2) a flat top, 3) a hexagon shaped cavity, and 4) a base that can be one of several different shapes.

Notice in Box B that the Hexagon Socket Set Screw has a cavity set down into the screw itself.

Observe in Box C that the cavity of the Hexagon Socket Screw has six sides. Hexagon means six sides.

Look at Box D. Can you see that the threads of the Hexagon Socket Set Screw go from the bottom of the screw to the top? The entire body is threaded.

Turn now to Box E. The Hexagon Socket Set Screw can have six different types of bases. This example has a pointed or conical base.

Notice in Box F that the base is hollow or recessed.

In Box G a rounded or domed base is shown.

The base shown in Box H is flat.

Box I shows another form of base where the threads have been removed to leave a smaller, unthreaded part of the base. This is called a full dog point.

The half dog shown in Box J is similar to the full dog point, but is shorter in length.

Look now at Box K. Recall that the Hexagon Socket Set Screw has four important parts: 1) a hexagon cavity in the top of the screw, 2) a flat top, 3) threads which go along the full length of the body, and 4) six different shapes of bases.

Box L shows two screws which are somewhat the same. Notice that number 2 has a head. Therefore, it is not a Hexagon Socket Set Screw.

In Box M there are two screws which look much the same. But notice that number 4 has a slot that is cut through the top of it. Therefore, it cannot be a Hexagon Socket Set Screw.

Look at Box N. You will see that number 6 is not threaded for the full length. It, therefore, cannot be a Hexagon Socket Set Screw.

Turn now to Box O. This shows bolts and screws that are not Hexagon Socket Set Screws. Notice that number 1 has a head. Number 2 has a straight slot cut through the top of it, and number 3 is partly unthreaded.

In Box P, once again look at the Hexagon Socket Set Screw and the six different shapes that can be attached to the base of the screw.

In Box Q, you can see different kinds of screws and bolts. With your pencil write the letters of those you think are Hexagon Socket Set Screws on the piece of paper given you. (45 second delay for reader) You should have listed the letters C, D, F, H, and I. If you have all five listed and no others you have a perfect score. If you missed some, or put some down that are not Hexagon Socket Set Screws, look over the ones you missed and see if you can tell why they are not Hexagon Socket Set Screws.

Script for Hexagon Head Bolt

In Box A you are looking at a Hexagon Head Bolt. To tell the Hexagon Head Bolt apart from other bolts and screws, you should look for five things: 1) a head with six flat sides, 2) a top surface that is flat, 3) a bearing surface that is square to the body, 4) a body that is partly threaded and partly unthreaded, and 5) a flat base.

In Box B you can see that the top surface of the Hexagon Head Bolt is flat.

In Box C observe that the bearing surface (or the underneath part of the head) is flat and at right angles with the body.

Look at Box D. Can you see that the head of the Hexagon Head Bolt has six flat sides? The word hexagon means six sides.

In Box E notice that the base of the body of the Hexagon Head Bolt is flat, it does not come to a point.

In Box F we can see that the upper part of the body of the Hexagon Head Bolt does not have threads, but the lower part does have threads.

Take a look at the Hexagon Head Bolts in Box G. You can see that they can be long or short, wide or narrow and can come in different shades and colors. However, they will always have:
1) a head with six sides, 2) a head with a flat top surface,
3) a bearing surface that forms a right angle with the body,
4) a body that is partly threaded and partly unthreaded, and
5) a flat base.

Both bolts shown in Box H have flat bases, partly threaded bodies, and a bearing surface that forms a right angle with the body. However, can you see that number 2 does not have six flat sides on the head nor a head with a flat top surface? Number 2 is not a Hexagon Head Bolt.

Look now at Box I. Notice that: the top surface of each head is flat; each head has six sides; the bearing surface of each bolt forms a right angle with the body; the body of each is partly threaded and partly unthreaded. Because the base of number 4 is pointed it cannot be a Hexagon Head Bolt.

In Box J we see that the top surfaces of both bolts have flat surfaces, six sided heads, bearing surfaces which form right angles with the bodies, and flat bases. But the threads on number 5 go from to to bottom. Number 5, therefore, is not a Hexagon Head Bolt.

Now look at the five bolts and screws in Box K. Can you tell why none of them is a Hexagon Head Bolt? The reasons are as follows: number 1 has threads along the whole body, number 2 does not have a six-sided head, nor is it flat on top of the head, number 3 has a pointed base and the threads go from top to bottom, number 4 also has a pointed base, and number 5 has a round head and a square neck.

The bolts in Box L are all Hexagon Head Bolts. Although they are different lengths, widths and colors, they all have:

six-sided, flat-topped heads, a bearing surface which forms a right angle with the body; a partly threaded and partly unthreaded body, and a flat base.

Box M contains drawings of many screws and bolts. Draw a line around all the ones which you thing are Hexagon Head Bolts. Write on the line at the bottom of the page the letters of all the ones you encircled. (READER: 45 second pause.) Have you written these letters - D, E, & I? If you have all three listed and no others, you have a prefect score. If you missed some or put down some that are not Hexagon Head Bolts, look over the ones you missed and see if you can tell why they are not Hexagon Head Bolts.

Scripts for Instructional Materials

Plumbing Valve Symbols

Script for Plumbing Symbols

Please open the booklet to the first page. Here you will see a message entitled "To The Student."

TO THE STUDENT

In this booklet, you will be learning to identify the symbols for three types of valves used in the plumbing trade. In addition, you will learn the symbols for three types of pipe joints.

Thank you for trying to learn these symbols. By doing so, you are helping us to learn how to be better teachers. Thank you, too, for doing the best you can. Now turn to Set A, The Globe Valve.

SET A

THE GLOBE VALVE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B, notice that a round dot placed in the center of the crossed lines is the symbol for a globe valve.

In Box C is the symbol for glove valve--a set of crossed lines with a large dot in the middle.

The symbol for the globe valve comes in different kinds of ends as shown in the bottom part of Box D, but it will always have the set of crossed lines with the large dot in the middle as shown in the top part of Box D.

Symbol #1 in Box E is a globe valve because it has crossed lines with a large dot in the middle. Number 2 is not the symbol for a globe valve because it does not have a dot in the middle of the crossed lines.

Symbol #1 in Box F is not the symbol for a globe valve because it does not have a dot in the middle of the crossed lines. Number 2 is the symbol for a globe valve because it has crossed lines with a large dot in the middle.

None of the valve symbols in Box G are symbols for the globe valve because they do not have the dot in the middle of the crossed lines.

All of the valve symbols in Box H are symbols for the globe valve because they have the two necessary parts: (1) a set of crossed lines, and (2) a dot in the middle of the crossed lines.

In Box I, there are several different types of valve symbols. Select all of the valve symbols that you think are symbols for the globe valve. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET B

THE SAFETY VALVE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B, notice that a big "S" placed in the center of the crossed lines is the symbol for safety valve.

In Box C is the symbol for a safety valve--a set of crossed lines with an S-shape in the middle.

The symbol for the safety valve can have different types of ends as shown in the bottom part of Box D, but it will always have the set of crossed lines with the S-shape in the center where the lines cross each other as shown in the top part of Box D.

Symbol #1 in Box E is not the symbol for a safety valve because it does not have the S-shape in the middle. Symbol #2 is the symbol for a safety valve because it has the crossed lines and the S-shape in the center.

Symbol #1 in Box F is the symbol for the safety valve because it has the S-shape in the middle. Symbol #2 is not the symbol for a safety valve--it does not have the S-shape.

None of the valve symbols in Box G are symbols for the safety valve because they do not have the S-shape in the center.

All of the valve symbols in Box H are symbols for the safety valve because they have the two necessary parts: (1) a set of crossed lines, and (2) an S-shape in the center of the crossed lines.

In Box I, there are several different types of valve symbols. Select all of the valve symbols that you think are the symbols for the safety valve. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET C

THE GATE VALVE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B, notice that the symbol for a gate valve is a set of crossed lines with nothing in the middle.

They symbol for the gate valve can have several types of ends as shown in Box C, but it will always have the crossed lines with nothing in the middle.

Symbol #1 in Box D is the symbol for a gate valve because it has crossed lines with nothing in the middle; number 2 is not the symbol for a gate valve because it has something in the middle of the crossed lines.

Symbol #1 in Box E is not the symbol for a gate valve because it has a dot in the middle of the crossed lines; #2 is the symbol for the gate valve because it has crossed lines with nothing in the middle.

None of the valve symbols in Box F is a gate valve symbol because each symbol has something in the middle of the crossed lines.

All of the valve symbols in Box G are symbols for the gate valve because they have the crossed lines with nothing in the middle where the lines cross.

In Box H there are several different types of valve symbols. Select all of the valve symbols that you think are the symbols for the gate valve. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET D

THE WELDED JOINT

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

There are five different ways to connect pieces of pipe to a valve. We are going to teach you the symbols for three of the ways for joining pipes to valves. In Box C, you can see pipe joints that have been welded. The symbol for a welded joint is an "X" across the lines which show where the pipe connects to the valve--think of the "X" as being a spark--when the pipe is welded, sparks fly everywhere near the spot where the pipe is being welded; so an "X" tells us that the piping is welded to the valve.

In Box D, you can see that if a valve is to be welded to a pipe, the X-shape (or spark shape) will be put on the lines at the end of the symbol.

Symbol #1 in Box E has joints that have been welded because the X-shape has been placed on the lines leading into the ends of the symbol; #2 has not been welded because it does not have the "X's" on the lines leading to the two ends of the symbol.

Symbol #1 in Box F has joints which have not been welded because they do not have "X's" on the lines at the two ends of the symbol; symbol #2 does not have joints that have been welded because there are no "X's" on the lines leading to the ends of the symbol; the joints for symbol #3 have been welded because there are "X's" on the lines leading to the two ends of the symbol.

None of the joints for the symbols in Box G have been welded because they do not have "X's" placed on the lines leading to the ends of the symbol.

All of the joints for the valve symbols in Box H have been welded because they each have "X's" on the lines leading to the ends of the symbols.

In Box I, select all of the valve symbols with joints in which the valve has been welded to the lead-in pipes. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET E

THE SOLDERED JOINT

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

There are five different ways to connect pieces of pipe to a valve. In Box C you can see the symbol for a pipe joint that has been soldered. The symbol for a soldered joint is an "O" across the lines that lead into the two ends of the valve symbol. Think of the circles as beads that are formed when the joint is soldered. All types of valves can be soldered as shown in Box D. When a valve is to be soldered to a piece of pipe, the symbol will have circles placed on the lines leading into the ends of the symbol.

Symbol #1 in Box E has joints that have not been soldered because circles have not been placed on the lines which lead into the ends of the symbol. Symbol #2 has joints which have been soldered because it has circles on the lines leading into the valve symbol. Symbol #3 has joints that have not been soldered because circles have not been placed on the lines which lead into the ends of the symbol.

Symbol #1 in Box F shows two joints that have been soldered, because circles have been placed across the lines that lead into the valve; symbol #2 does not have soldered joints because it does not have the circles across the two ends of the symbol; symbol #3 does not have soldered joints because it does not have the circles across the lines that lead into the symbol.

None of the joints for the symbols in Box G have been soldered because they do not have the circles placed on the lines leading into the ends of the valve symbol. All of the joints for the valve symbols in Box H will be soldered joints because circles have been placed on the lines leading into the valve symbols.

In Box I, select all of the valve symbols with joints in which the valve has been soldered to the lead-in pipes. Put your answer on the answer sheet provided. Please do not make any marks in the booklet.

SET F

THE THREADED JOINT

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

There are five different ways to connect pieces of pipe to a valve. In Box C, you can see the symbol that is used to show that pieces of pipe will be joined to a valve with the use of threads. Or in other words, that the pipe will be screwed into the valve openings. The symbol to show that a piece of pipe has been joined by threads to a valve is a single perpendicular line at the end of the valve symbol. When joints are to be threaded, the lead-in lines which join the lines of the valve symbol will not have crosses or circles on them.

In Box D different types of valves are shown connected to pieces of pipe by threads. The lead-in lines will not have any circles or crosses.

Symbol #1 in Box E has joints that are threaded together because there is a single up-and-down or perpendicular line at the ends of the symbol and there are no crosses or circles on the lines leading into the valve symbol. Symbol #2 has joints which are not threaded because there are double lines at the ends of the symbols.

Symbol #1 in Box F has joints which have not been connected by threads. The crosses or "X's" on the lines leading into the ends of the symbol shows that these joints have been welded instead of connected by threads. Valve symbol #2 has joints that are connected by threads; valve symbol #3 has joints that are connected by solder as shown by the circles on the lines leading into the ends of the valve symbol.

None of the symbols in Box G show pipes joined to the valves by threads.

All of the symbols in Box H show pipes joined to the valves by threads. There are no "X's" or circles on the lead-in lines, and the ends of the valve are perpendicular to the lead-in lines.

In Box I, select all of the valve symbols which show lead-in pipes which are joined to valves by threads. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET G

THE COLD WATER PIPE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

By looking at the plumbing symbol in Box C, we can tell what type of valve is to be used. We can also tell how the lead-in pipe is fastened to the valve. Finally, we tell if the pipe leading into the valve is for hot water or cold water.

In Box D, the two arrows are pointing to the pipe lines that lead into the valve. By looking at the lines leading into the ends of the valve symbol, we can tell if they are made for hot water or for cold water.

In Box E is a cold water pipe which is shown by a broken lead-in line that is made up of a dash followed by a single dot.

In Box F, all of the valves have cold water pipes leading into them because the lead-in lines are made up of dashes followed by a single dot.

In Box G, valve symbol #1 has a cold water pipe leading into it because it is a dash followed by a dot. Remember the symbol for a cold water pipe is dash-dot, dash-dot, dash-dot. Symbol #2, therefore, does not show a cold water pipe leading into the valve because it has dashes followed by two dots instead of one.

None of the valve symbols in Box H show cold water going into the valve because none of them are made up of a dash followed by just one dot.

All of the valve symbols in Box I show cold water going into the valve because the lead-in lines are made up of a dash followed by just one dot.

In Box J, select all of the valve symbols which show cold water lead-in pipes. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET H

THE HOT WATER PIPE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of the valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

By looking at the plumbing symbol in Box C, we can tell what type of valve is to be used. We can also tell how the lead-in pipe is fastened to the valve. Finally, we tell if the pipe leading into the valve is for hot water or cold water.

In Box D, the two arrows are pointing to the pipe lines that lead into the valve. By looking at the lines leading into the ends of the valve symbol, we can tell if they are made for hot water or for cold water.

In Box E, a hot water pipe is shown by a broken lead-in line that is made up of a dash followed by two dots.

In Box F, all of the valves have hot water pipes leading into them because the lead-in lines are made up of dashes followed by two dots.

In Box G, valve symbol #1 has a hot water pipe leading into it because it has dashes followed by two dots. Remember that the symbol for a hot water pipe is dash-dot-dot, dash-dot-dot, dash-dot-

dot. Symbol #2, therefore, does not show a hot water pipe leading into the valve because it has dashes followed by one dot instead of two.

None of the valve symbols in Box H show hot water going into the valve because none of them are made up of a dash followed by two dots.

All of the valve symbols in Box I show hot water going into the valve because the lead-in lines are made up of a dash followed by two dots.

In Box J, select all of the valve symbols which show hot water lead-in pipes. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

Scripts for Instructional Materials

Common Knives

Common Knives

TO THE STUDENT

As you know, there are many types of knives and many types of knife blades and handles. All knives are used to cut, but certain knives have been designed for special uses. For the next 10-15 minutes, you will be told about seven types of knives and their uses.

Thank you for completing this lesson. By doing so, you are helping us to learn how to be better teachers. Thank you also for doing the best you can on this lesson. Now turn to the next page, where you will see a picture of the Utility knife.

The Utility Knife

Look at Box A. The knife shown in Box A is called a utility knife. A utility knife has four different blades, all of which are shorter than the handle so that they will fit into the handle when they are folded. Two of the blades are attached at one end of the knife and two at the other end. The handle of the utility knife is usually made of metal and covered with wood, plastic, or bone trim.

In Box B you can see one of the blades of the utility knife. It is a short blade with a cutting edge that is straight all the way to the tip. This blade is used for cutting curved outlines, for scraping materials, and for certain types of whittling.

In Box C notice that the utility knife has a blade that is hook-shaped in the lower portion and shaped like a screwdriver at the tip. The hooked part of the blade is used as a bottle opener, while the top is used like a screwdriver.

In Box D you can see yet another hook-shaped blade. This blade, however, has a pointed tip rather than a flat one. This blade is used for opening cans or can be used to punch holes in certain objects, like leather or plastic.

In Box E you can see that the utility knife has a regular blade called a pen blade. This blade, when kept sharp, can be used to cut just about any material that is softer than the blade itself.

Now to review, look at Box F where you will see a utility knife. Remember that the utility knife has four different blades:

--one regular pen knife blade;
--one hook-shaped can opener blade;
--one straight-shaped scraper blade;
--one combination bottle opener/screwdriver blade.

In Box G there are two knives, one is a utility knife and one is not. Ex. 1 is not a utility knife because it has only two blades. Ex. 2 is a utility knife because it has the four blades a utility knife is supposed to have.

In Box H there are two more knives. Ex. 1 is a utility knife. Ex. 2 is not a utility knife because the four blades are not shaped like those of a utility knife.

Now look at Box I. None of these is a utility knife. Can you see why? None of them has the four blades that a utility knife must have.

In Box J there are several different types of knives. On the answer sheet provided circle the letters of the ones that you think are utility knives. Please do not mark on the booklet.

The Hunting Knife

In Box A is a hunting knife. The hunting knife has a single blade and a single cutting surface. The handle is curved to fit the grip of a person's hand.

In Box B the arrows point to the handle of the hunting knife which is curved in the middle and rounded at the end. The handle of a hunting knife is made of steel and can be covered with different materials, such as leather, plastic, or bone.

Look at Box C. The point at which the blade meets the handle is called the guard. The arrow in Box C points to the guard.

The arrow in Box D shows that the cutting surface of the hunting knife curves upward so that it forms a pointed tip. The blade of a hunting knife does not fold and can be different lengths.

In Box E you can see some of the things that a hunting knife can be used for. It can be used to cut rope, to cut branches, and to skin an animal. Most of the time, hunting knives are used outdoors.

Look at Box F which shows a hunting knife. Try to remember these things. First, the handle is rounded at the end; second, there is a guard between the blade and the handle; and third, the blade has only one side that is used for cutting and curves upward to form a pointed tip.

In Box G there are two knives. Example 1 is a hunting knife. Ex. 2 is not a hunting knife because it's blade does not curve upward in the same way as the blade of a hunting knife. Also, it does not have a guard between the blade and the handle.

The knives in Box H are not hunting knives because they are not shaped like a hunting knife, nor are they designed to do the things for which a hunting knife is used.

Now look at Box I where you will see several types of knives. Some are hunting knives and some are not. On your answer sheet, please circle the letters of the ones that you think are hunting knives.

The Fish Knife

The knife shown in Box A is a fish knife. It has two folding blades. Both blades are attached at the same end of the knife and fold into the handle. The handle is made of metal with different materials for the outside trim, usually plastic or bone.

The arrow in Box B points to the curved part of the handle which is used to re-shape bent fishhooks.

Box C shows one of the blades of the fish knife. This type of blade is called a clip blade. It is a narrow blade that curves up slightly at the tip. The top of the blade is flat near the back and curved near the front tip. The arrow points to the curved top part of the blade. The clip blade of the fish knife can be used to cut fishing line, to cut cord for repairing fish nets, to cut materials used in making fish lures, or to cut up bait.

In Box D the scaler blade is shown. This blade has ridges which are used to clean fish by scraping off the scales. The arrow points to a notch on the end of the scaler blade. This notch with its fork-shaped prongs is called a disgorger and is used to help remove fishhooks from the mouths of fish.

For review, look at Box E where you see a fish knife. The fish knife has three important parts:

--a clip blade that is narrow and curves up slightly at the end;
--a scaler blade with ridges and a notched prong on the end;
--a handle with a curved end for re-shaping fishhooks.

In Box F. Ex. 1 is not a fish knife because it does not have a scaler blade or a curved handle. Ex. 2 is a fish knife because it has a clip blade, scaler blade, and curved handle.

None of the knives in Box G are fish knives because they do not have a clip blade, scaler blade, and curved handle.

Now look at Box H where you will see several different knives. Some of them are fish knives and some are not. On the answer sheet provided, circle the letters of the ones that you think are fish knives.

The Butcher Knife

A butcher knife is shown in Box A. The butcher knife has a long blade that does not fold. The handle is always shorter than the blade and can be made of different materials, usually wood or plastic.

In Box. B the arrow shows that the cutting edge of the butcher knife curves up at the end. The curved part is also wider than the rest of the blade.

In Box C the arrow points to the tip of the blade. The upper part of the tip is called the false edge because it is not used for cutting. A butcher knife will always have this straight, slanted false edge at the tip of the blade.

Box D shows several uses of a butcher knife. It is used to cut, separate, and cube meat, like a round steak, before it is cooked. A butcher knife can also be used to cut up a chicken for frying or baking. Another use would be to cut and separate fish.

Now to review, look at Box E where you see a butcher knife. Notice the three important parts:

--a long, nonfolding blade that is longer than the handle;
--the curved cutting edge;
--the flat part, false edge, on top of the tip of the blade.

In Box F, Ex. 1 is a butcher knife because it has a long blade that is curved at the tip with a flat, false edge, on top of the tip. Ex. 2 is not a butcher knife because it does not have the flat, false edge on top of the tip, and the blade is not wide at the curved part.

In Box G none of the knives are butcher knives. Ex. 1 is not a butcher knife since it does not have a long blade with a wide, curved part and a flat, false edge on the tip. Ex. 2 is not a butcher knife because the blade is to wide at the back and does not have a flat, false edge on the tip. Ex. 3 is not a butcher knife since it does not have a flat, false edge on the tip and the handle has a guard on the front and a curved end.

Now look at Box H where you will see several different types of knives, some of which are butcher knives and some are not. On the answer sheet provided, circle the letters of the ones that you think are butcher knives.

The Paring Knife

Box A contains a drawing of a paring knife. It is a fairly short knife with a single non-folding blade.

In Box B you can see that the handle of a paring knife is a little longer than the blade. The handle can be made of different materials, but is usually made of wood or plastic fastened to the metal end of the blade.

In Box C the arrows point to the tip of the blade of the paring knife. As you can see, the blade comes to a pointed tip. The cutting edge of the blade curves just a little, while the upper part of the blade's tip curves in a sloping manner.

In Box D you can see that a paring knife can be used to pare, peel, and slice fruits and vegetables.

To review, look at Box E where you will see a paring knife. Notice the important parts of a paring knife:

--a handle that is longer than the blade;
--a non-folding short blade that is slightly curved at the tip.

In Box F, Ex. 1 is not a paring knife because the blade is longer than the handle and there is not a curved part on the top of the tip of the blade. Ex. 2 is a paring knife because it has the short blade and the curved top on the tip.

None of the knives in Box G are paring knives. Ex. 1 is not a paring knife because it has a folding blade. Ex. 2 is not a paring knife since it has a long, wide blade and a flat part on top of the tip of the blade. The knife in Ex. 3 is not a paring knife because the blade has ridges and does not have a pointed tip.

In Box H you will see several different types of knives. Some are paring knives and some are not. On the answer sheet provided, circle the letters of the ones that you think are paring knives.

The Pruning Knife

In Box A you are looking at a pruning knife. The pruning knife has one folding blade. The blade is a little shorter than the handle so that when it is closed the blade will fit into the handle. The handle of the pruning knife is made of metal with different materials on each side. This trim is usually made of wood, plastic, or bone.

Box B shows the pruning knife with the blade open. The arrow points to the hook-shaped tip of the wide blade. Sometimes the blade is called a "Hawk Bill Blade" since it is shaped like a hawk's bill.

Box C shows that the pruning knife can be used to prune and trim shrubs and bushes. It can also be used to trim small branches and leaves on a tree.

Box D again shows the pruning knife with the folding blade that is wide and hook-shaped.

In Box E are drawings of two knives: Ex. 1 is a pruning knife. Ex. 2 is not a pruning knife because it does not have the wide, hooked-shaped blade.

In Box F none of the knives shown are pruning knives since they do not have the wide, hooked-shaped blade.

Now look at Box G where you will see several types of knives. Some are pruning knives and some are not. On the answer sheet provided, circle the letters of the ones that you think are pruning knives.

The Meat Cleaver

A meat cleaver is shown in Box A. This knife is fairly heavy with a big, flat blade. The handle is smaller than the blade.

In Box B the arrow points to the blade. As you can see, the blade of the meat cleaver is a large, flat blade that has a straight cutting edge. The front end of the blade is flat and comes down so that the cleaver can be hung on a nail or hook.

In Box C the arrow points to the handle that is smaller than the blade and is usually made of wood or plastic with part of the metal blade sandwiched in the middle.

Box D shows that a meat cleaver is used to separate foods, such as meat with tough bone or muscle, with a forceful blow. Also, foods that have been frozen, such as the corn shown, can be cut into smaller pieces with a meat cleaver.

To review. Look at Box E. Remember the meat cleaver has:

--a large, flat blade with a flat front end;
--a hole in the corner of the blade for hanging;
--a handle that is smaller than the blade.

In Box F. Ex. 1 is a meat cleaver. Ex. 2 is not a meat cleaver because it does not have a large, flat blade with a flat front end.

None of the knives in Box G are meat cleavers. None of them have a large, flat blade with a flat front end and a smaller handle.

In Box H you will see several different types of knives. Some of these are meat cleavers and some are not. On the answer sheet provided, circle the letters of the ones that you think are meat cleavers.

Scripts for Instructional Materials

Plumbing Valve Symbols
with Verbal Cues

Script Containing Verbal Cues for Plumbing Symbols

Please open the booklet to the first page. Here you will see a message entitled "To The Student".

TO THE STUDENT

In this booklet, you will be learning to identify the symbols for three types of valves used in the plumbing trade. In addition, you will learn the symbols for three types of pipe joints.

Thank you for trying to learn these symbols. By doing so, you are helping us to learn how to be better teachers. Thank you, too, for doing the best you can. Now turn to Set A, The Globe Valve.

SET A

THE GLOBE VALVE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B, notice that a round dot placed in the center of the crossed lines is the symbol for a globe valve.

In Box C is the symbol for globe valve--a set of crossed lines with a large dot in the middle.

Think of a globe -- the kind of globe that shows all the countries and places in the world. A globe is a kind of world map on a large ball, so it is always round. When you want to remember a globe valve just think of a globe that is a world map on a ball. A globe valve will have a round ball shape, globe, in the middle of the crossed lines.

The symbol for the globe valve comes in different kinds of ends as shown in the bottom part of Box D, but it will always have the set of crossed lines with the large dot or globe shape in the middle as shown in the top part of Box D.

Symbol #1 in Box E is a globe valve because it has crossed lines with a large dot or globe shape in the middle. Number 2 is not the symbol for a globe valve because it does not have a round globe shape in the middle of the crossed lines.

Symbol #1 in Box F is not the symbol for a globe valve because it does not have a round dot or globe shape in the middle of the crossed lines with a large dot or globe shape in the middle.

None of the valve symbols in Box G are symbols for the globe valve because they do not have the dot or globe shape in the middle of crossed lines.

All of the valve symbols in Box H are symbols for the globe valve because they have the two necessary parts: (1) a set of crossed lines, and (2) a round dot or globe shape in the middle of the crossed lines. Remember for a globe valve think of the round dot as a globe -- a map of the world.

In Box I, there are several different types of valve symbols. Select all of the valve symbols that you think are symbols for the globe valve. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET B

THE SAFETY VALVE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B, notice that a big "S" placed in the center of the crossed lines is the symbol for safety valve.

In Box C is the symbol for a safety valve--a set of crossed lines with an S-shape in the middle.

You can think of superman when you see the big 'S' shape. In the comics superman wears a costume that has a big 'S' on the front. And in everything he does he tries to make people safe. So for superman and safety, think of the big 'S' which is the first letter of each word.

The symbol for the safety valve can have different types of ends as shown in the bottom part of Box D, but it will always have the set of crossed lines with the S-shape for safety and superman in the center where the lines cross each other as shown in the top part of Box D.

Symbol #1 in Box E is not the symbol for a safety valve because it does not have the S-shape in the middle. Symbol #2 is the symbol for a safety valve because it has the crossed lines and the S-shape in the center. Remember the 'S' for safety and superman.

Symbol #1 in Box F is the symbol for the safety valve because it has the S-shape for safety and superman in the middle. Symbol #2 is not the symbol for a safety valve--it does not have the S-shape.

None of the valve symbols in Box G are symbols for the safety valve because they do not have the S-shape in the center standing for safety and superman.

All of the valve symbols in Box H are symbols for the safety valve because they have the two necessary parts: (1) a set of crossed lines, and (2) an S-shape in the center of the crossed lines. Remember for a safety valve think of the big 'S' for safety and superman.

In Box I, there are several different types of valve symbols. Select all of the valve symbols that you think are the symbols for the safety valve. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET C

THE GATE VALVE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B, notice that the symbol for a gate valve is a set of crossed lines with nothing in the middle.

The symbol for the gate valve can have several types of ends as shown in Box C, but it will always have the crossed lines with nothing in the middle.

For a gate valve think of a gate in a fence. Out in the country a gate in a fence usually has two cross pieces of wood or metal. So if you are looking at a fence and you see a big 'X' shape in the fence, you will know that it is the gate.

Symbol #1 in Box D is the symbol for a gate valve because it has crossed lines like a gate in a fence with nothing in the middle; number 2 is not the symbol for a gate valve because it has something in the middle of the crossed lines.

Symbol #1 in Box E is not the symbol for a gate valve because it has a dot in the middle of the crossed lines; #2 is the symbol for the gate valve because it has crossed lines with nothing in the middle like a gate in a fence.

None of the valve symbols in Box F is a gate valve symbol because each symbol has something in the middle of the crossed line not just plain cross pieces like on a gate in a fence.

All of the valve symbols in Box G are symbols for the gate valve because they have the crossed lines with nothing in the middle where the lines cross. Remember to think of the two cross pieces of a gate in a fence.

In Box H there are several different types of valve symbols. Select all of the valve symbols that you think are the symbols for the gate valve. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET D

THE WELDED JOINT

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

There are five different ways to connect pieces of pipe to a valve. We are going to teach you the symbols for three of the ways for joining pipes to valves. In Box C, you can see pipe joints that have been welded. The symbol for a welded joint is an "X" across the lines which show where the pipe connects to the valve--think of the "X" as being a spark--when the pipe is welded, sparks fly everywhere near the spot where the pipe is being welded; so an "X" tells us that the piping is welded to the valve.

In Box D, you can see that if a valve is to be welded to a pipe, the X-shape or spark shape will be put on the lines at the end of the symbol.

Symbol #1 in Box E has joints that have been welded because the X-shape like welding sparks has been placed on the lines leading into the ends of the symbol; #2 has not been welded because it does not have the "X's" or sparks on the lines leading to the two ends of the symbol.

None of the joints for the symbols in Box G have been welded because they do not have "X's" or sparks placed on the lines leading to the ends of the symbol.

All of the joints for the valve symbols in Box H have been welded because they each have "X's" on the lines leading to the ends of the symbols. Remember to think of the "X's" as the sparks that fly everywhere when something is welded.

In Box I, select all of the valve symbols with joints in which the valve has been welded to the lead-in pipes. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET E

THE SOLDERED JOINT

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

There are five different ways to connect pieces of pipe to a valve. In Box C you can see the symbol for a pipe joint that has been soldered. The symbol for a soldered joint is an "O" across the lines that lead into the two ends of the valve symbol. Think of the circles as beads like lumps of solder that are formed when the joint is soldered. All types of valves can be soldered as shown in Box D. When a valve is to be soldered to a piece of pipe, the symbol will have circles like lumps of solder placed on the lines leading into the ends of the symbol.

Symbol #1 in Box E has joints that have not been soldered because circles have not been placed on the lines which lead into the ends of the symbol Symbol #2 has joints which have been soldered because it has circles like lumps of solder on the lines leading into the valve symbol. Symbol #3 has joints that have not been soldered because circles have not been placed on the lines which lead into the ends of the symbol.

Symbol #1 in Box F shows two joints that have been soldered, because circles like lumps of solder have been placed across the lines that lead into the valve; symbol #2 does not have soldered joints because it does not have the circles across the two ends of the symbol; symbol #3 does not have soldered joints because it does not have the circles across the lines that lead into the symbol.

None of the joints for the symbols in Box G have been soldered because they do not have the circles like lumps of solder placed on the lines leading into the ends of the valve symbol. All of the joints for the valve symbols in Box H will be soldered joints because circles have been placed on the lines leading into the valve symbols. Remember for a soldered pipe joint the valve symbol will have circles like lumps of solder placed on the lines leading into the symbol.

In Box I, select all of the valve symbols with joints in which the valve has been soldered to the lead-in pipes. Put your answer on the answer sheet provided. Please do not make any marks in the booklet.

SET F

THE THREADED JOINT

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

There are five different ways to connect pieces of pipe to a valve. In Box C, you can see the symbol that is used to show that pieces of pipe will be joined to a valve with the use of threads. Or in other words, that the pipe will be screwed into the valve openings. The symbol to show that a piece of pipe has been joined by threads to a valve is a single perpendicular line at the end of the valve symbol with a plain line leading into the symbol. When joints are to be threaded, the lead-in lines which join the lines of the valve symbol will not have crosses or circles on them. A piece of metal that is to be threaded or screwed onto something already has its threads on it--welding or soldering will not be added to it. So the symbol of a threaded pipe connection will be a plain, straight line like just plain threads leading into the symbol. Also, if you look at the symbol sideways you will see a big 'T' which is the first letter of the word "threaded".

In Box D different types of valves are shown connected to pieces of pipe by threads. The lead-in lines will not have any circles or crosses just plain lines like plain threaded pipe that is not welded or soldered.

Symbol #1 in Box E has joints that are threaded together because there is a plain up-and-down or perpendicular line at the ends of the symbol with a plain lead-in pipe and there are not crosses or circles on the lines leading into the valve symbol. Symbol #2 has joints which are not threaded because there are double lines at the ends of the symbols.

Symbol #1 in Box F has joints which have not been connected by threads. The crosses or "X's" on the lines leading into the ends of symbol shows that these joints have been welded instead of connected by threads. Valve symbol #2 has joints that are connected by threads; valve symbol #3 has joints that are connected by solder as shown by the circles on the lines leading into the ends of the valve symbol.

None of the symbols in Box G show pipes joined to the valves by threads. They all have something on the lead-in lines.

All of the symbols in Box H show pipes joined to the valves by threads. There are no "X's" or circles on the lead-in lines, and the ends of the valve are perpendicular to the lead-in lines. Remember a threaded connection will have plain, straight lines like plain, threaded pipes leading into the symbol.

In Box I, select all of the valve symbols which show lead-in pipes which are joined to valves by threads. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET G

THE COLD WATER PIPE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of a valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

By looking at the plumbing symbol in Box C, we can tell what type of valve is to be used. We can also tell how the lead-in pipe is fastened to the valve. Finally, we tell if the pipe leading into the valve is for hot water or cold water.

In Box D, the two arrows are pointing to the pipe lines that lead into the valve. By looking at the lines leading into the ends of the valve symbol, we can tell if they are made for hot water or for cold water.

In Box E is a cold water pipe which is shown by a broken lead-in line that is made up of a dash followed by a single dot. Remember that one dot means cold ... one is for cold ... one is for cold.

In Box F, all of the valves have cold water pipes leading into them because the lead-in lines are made up of dashes followed by a single dot ... one is for cold ... one is for cold.

In Box G, valve symbol #1 has a cold water pipe leading into it because it is a dash followed by a dot ... one dot for cold. Remember the symbol for a cold water pipe is dash-dot, dash-dot, dash-dot. Remember one dot for cold. Symbol #2, therefore, does not show a cold water pipe leading into the valve because it has dashes followed by two dots instead of one.

None of the valve symbols in Box H show cold water going into the valve because none of them are made up of a dash followed by just one dot.

All of the valve symbols in Box I show cold water going into the valve because the lead-in lines are made up of a dash followed by just one dot. So for cold water pipes remember one dot for cold.

In Box J, select all of the valve symbols which show cold water lead-in pipes. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

SET H

THE HOT WATER PIPE

In Box A you can see the symbol for a valve. A valve is shown as a set of crossed lines.

In Box B you can see that by looking at the ends of the valve symbol, we can tell how a particular valve is fastened or hitched to the pieces of pipe that connect to the valve.

By looking at the plumbing symbol in Box C, we can tell what type of valve is to be used. We can also tell how the lead-in pipe is fastened to the valve. Finally, we tell if the pipe leading into the valve is for hot water or cold water.

In Box D, the two arrows are pointing to the pipe lines that lead into the valve. By looking at the lines leading into the ends of the valve symbol, we can tell if they are made for hot water or for cold water.

In Box E, a hot water pipe is shown by a broken lead-in line that is made up of a dash followed by two dots. To help you remember this think of this rhyme 'Two dots, too hot' ... 'Two dots, too hot!'

In Box F, all of the valves have hot water pipes leading into them because the lead-in lines are made up of dashes followed by two dots ... two dots, too hot ... two dots, too hot.

In Box G, valve symbol #1 has a hot water pipe leading into it because it has dashes followed by two dots ... two dots, too hot. Remember that the symbol for a hot water pipe is dash-dot-dot, dash-dot-dot, dash- dot-dot. Remember two dots mean too hot.

Symbol #2, therefore, does not show a hot water pipe leading into the valve because it has dashes followed by one dot instead of two.

None of the valve symbols in Box H show hot water going into the valve because none of them are made up of a dash followed by two dots.

All of the valve symbols in Box I show hot water going into the valve because the lead-in lines are made up of a dash followed by two dots. So for hot water pipes remember 'two dots, too hot.'

In Box J, select all of the valve symbols which show hot water lead-in pipes. Put your answers on the answer sheet provided. Please do not make any marks in the booklet.

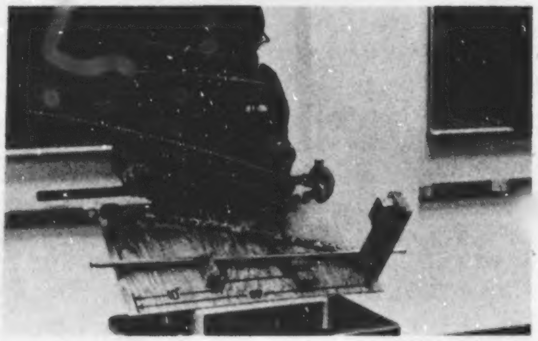
APPENDIX C

Praxiological Lesson Format:
Pictorial Analysis and Script

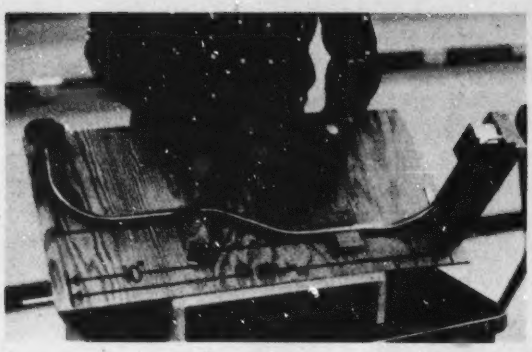
LESSON PRESENTATION

BENDING ELECTRICAL METALLIC TUBING: A PICTORIAL ANALYSIS AND SCRIPT

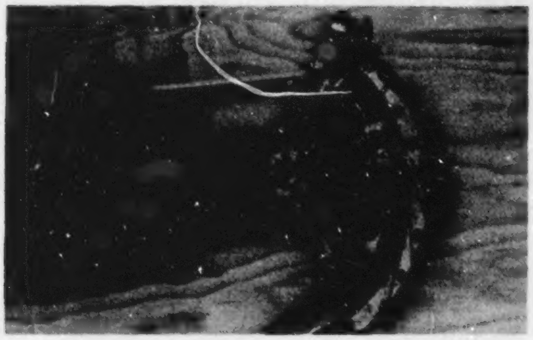
It's good to be here this morning at your school. Before we get started, let me introduce myself. My name is Robert Gish; this is Berta Ortiz, and Bob Rios. We're all from Texas A&M University. Let me explain to you exactly what we're going to do today. At A&M, we are studying ways to train teachers. We want students who come to A&M to become better qualified and better prepared teachers, so that when they come to your high school, they can teach students the things that they need to know in the best way possible. We're going to teach you to do a task, and this will help us tell teachers what they need to know to teach better. You'll notice that we've got several different things here. You might think they look strange, but as I explain to you what they're used for, I think you will understand more about the lesson that we're going to teach you.



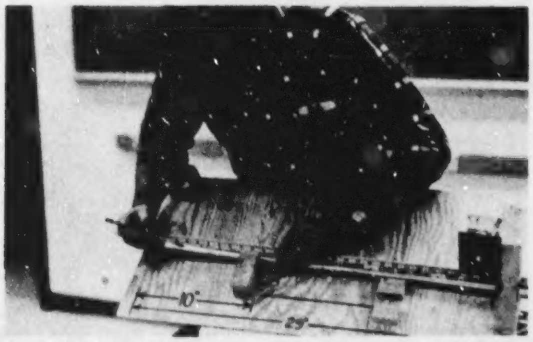
You'll notice, first of all, a board with some blocks on it. This is going to be a practice board, and we're going to pretend that it's part of a building that's being constructed. This tool that you see here is called a Benfield Bender. It is used to bend electrical tubing. Do any of you know what electrical conduit is, or electrical metallic tubing? Well, you've probably seen it right here in your classroom, even though you didn't realize it. Just look over there in the corner. See that pipe going up the wall there? Inside that pipe or conduit are electrical wires. The pipe is bent around so that it comes down from the ceiling, down to the bottom, along and across the bottom of the wall, and up to the light switch or plug. There's electrical wiring inside that pipe. What we're going to teach you today is how to take a piece of electrical metallic tubing, and, using this bender, bend the conduit.



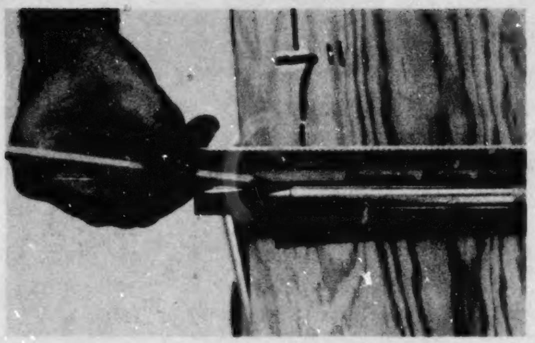
OK? Let's go ahead and get started. Like I said, we're going to pretend that on this board we have a junction box right up here. We'll take the pipe and go down seven inches, until the pipe comes across this floor joist. Then we're going to have to curve the pipe down here between this wall. You don't see the wall, but let's pretend it's there, and that we've got a hole through it. We've got to put our pipe through this wall, then have to come over and up the side of this wall to a light switch. That gives us three bends: we've got what's called a stub bend that comes down from the junction box seven inches; then when we go over the floor support and down through another wall, we've got an offset bend; and then after we've come up this other wall, right up to the light switch, we've got a back-to-back bend. I'm going to show you each one of these bends, one at a time. Then you can learn how to use the Benfield Bender to bend your electrical metallic tubing so that it will fit as well as the one that you see.



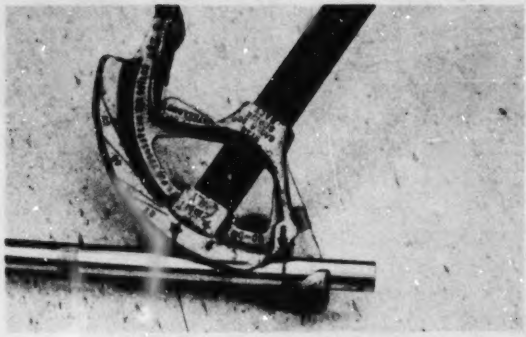
But before we get started, let me show you something about this bender. You'll notice there's an arrow here on the head. Each one of you look at this arrow. We're going to use that in a little bit, and when we do I'll tell you exactly how to do it. You'll also notice a star. This is called the starpoint. We will use that later on, too. And then, along the edge here, you will see lines with numbers. These are degree markings. Can you see those? We will be using degree markings later on when we make our offset bend, and I'll show you how to do that, too. I just wanted to point these marks out to you before we get started.



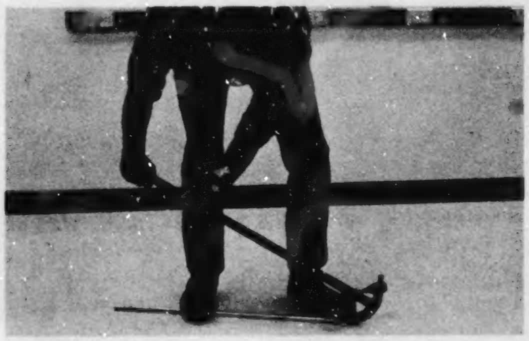
OK, let's take our tubing and make that first bend. Well, the first thing that we need to know is that when you put your tubing into the bender, the bender itself is going to use five inches of the tubing. To make a seven-inch bend, we're going to measure down two inches, aren't we? We want seven inches; the bender uses five inches; then we must measure down two inches on our tubing to make up the difference.



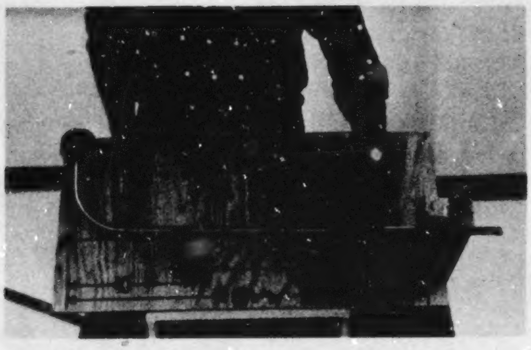
Let's do that right now. We'll take our tubing first, then put the end of the yardstick next to the end of the tubing, and make a mark at two inches onto the tubing. Now, to see that mark when we put the conduit on the bender we will have to make that mark go all the way around the conduit. See how I'm doing it? All the way around, just like that. OK.



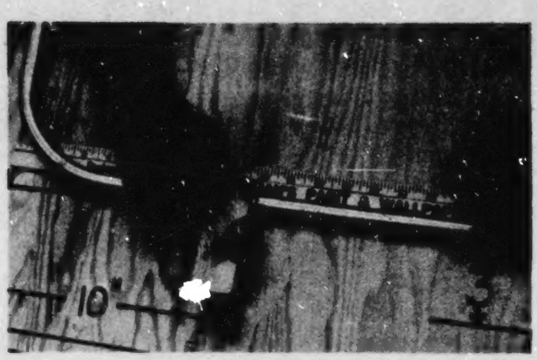
Once you have it marked, then we're ready to do the bends. Now, this is where we use that arrow point. After placing our tubing into the bender like this, we have to line up the arrow with our two-inch mark. Can everyone see that now? Once I have the arrow lined up with the two-inch mark, and the bender on the floor, I am ready to make the bend.



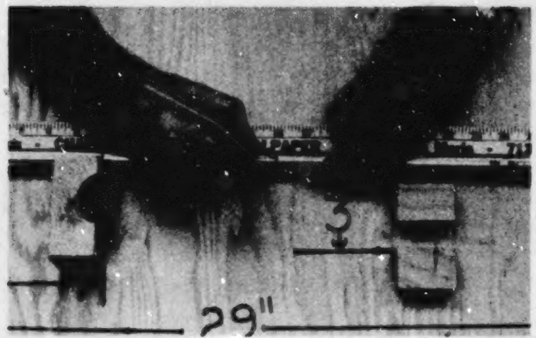
It's a little tricky, but if you take your time, I think you'll be able to do this. Grab the handle of the bender with your hand, place one foot on the tubing, and then put your other foot on the step of the bender. I'm going to step down on the bender, pull with my hands, and bend that pipe straight up in the air. OK? Step down and pull. Just keep going till the pipe gets straight up. Now you may want to stop and take a look at it and see if it's exactly like you want it. You may have to bend it just a little bit more to get it as straight as you want it. But once finished, we have our first bend.



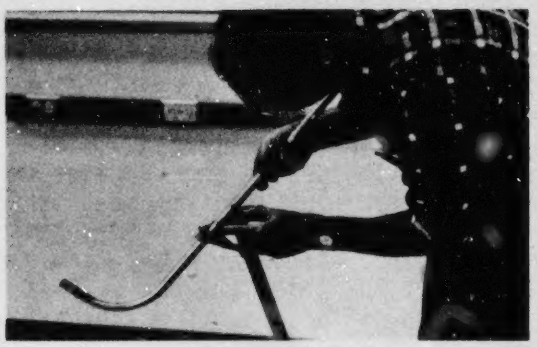
Let's take it out of the bender now, put it back on the board, and see what it looks like. All right. It looks pretty good. This is our first seven-inch stub bend. Now that you've seen me do it, why don't you take your board and bender, get a piece of tubing from Berta, and practice this first bend for yourselves.



OK. Now that everybody's had a chance to practice that first bend, let's go to the offset bend. Remember, I said we're going to come over this floor joist or support then down and through this wall. You'll notice that on the board, it says there's a three-inch difference - a three inch drop from the floor support to the hole in the wall. That's why this is called a three-inch offset bend. From some tables in a book, we can learn exactly how many extra inches we're going to have to measure on our tubing for a three inch, thirty degree offset bend. The first measurement is ten inches over from the back of the stub bend, so from the very back of the first bend, we have to measure over ten inches. Because we've got to go over that support in the floor, we make our first mark right beside this block or floor support where it is marked ten inches.

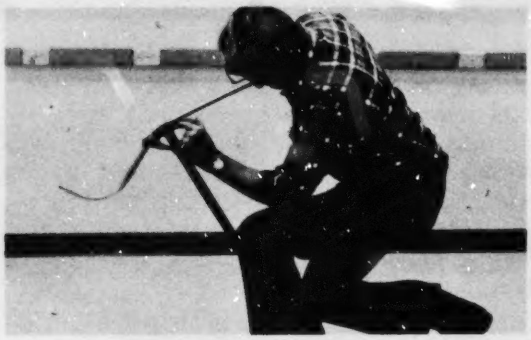


Now, the tables in the book tell us that, for a thirty-degree, three-inch offset bend, we're going to have to measure six inches over from our ten inch mark. Just believe me when I tell you this: to make this bend correctly you must measure over six more inches from your first mark. Also, be sure to make your second mark before you start your bend. If you do the bend first, you're not going to be able to mark the pipe correctly. So make the first ten-inch mark, then measure over six more inches with your yardstick. We've already made the first mark; let's measure over six more inches to make our second mark. And on both of these again, we will mark the pipe all the way around, so we will be able to see where our mark is when we put it in our bender.

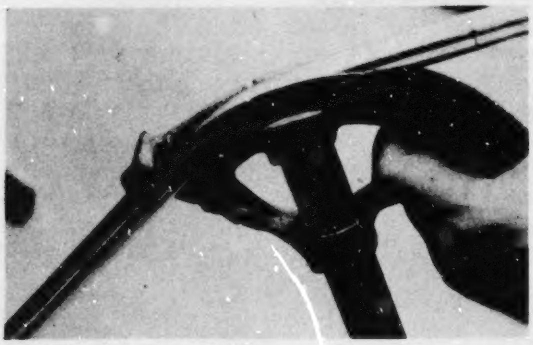


Now this bend is a little different than the first bend, because this time we turn the bender upside down. We put the handle on the floor, then put the pipe into the bender. Remember, just like last time, to line up the mark with the arrow.

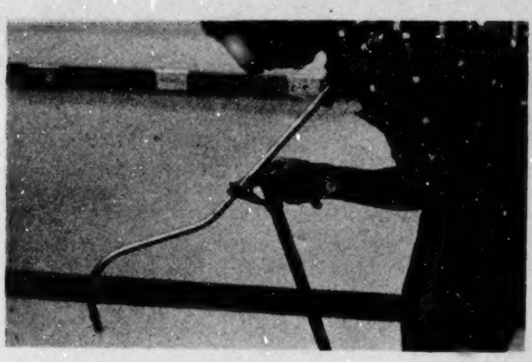
Now, I must also make sure that the end of the pipe that I've already bent, the stub bend, is sticking straight up in the air like this. Just like I'm showing with my hand, make the pipe stick straight up before you make your bend.



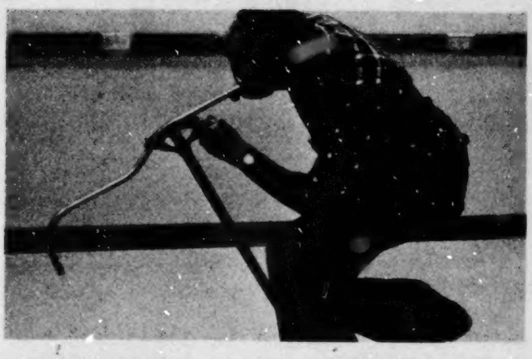
Now what we're going to do is get our pipe up underneath our arm pits so that we have better control of the bender. If we stick it out like this with our hands on the very end, the bender's going to fall on the floor and might hurt someone, so we want to get down close on it with the pipe underneath our arm pit. You might even want to put one foot up next to the handle to keep it from slipping. Then just squat down and let your body weight bend the pipe.



Now we're ready to use those degree markings. While you're pushing you have to keep watching so that the pipe bends down to where it lines up with the thirty degree mark on the bender. Keep bending till you're ready to stop and check your pipe. I'm going to stop here. OK, I'm right at thirty degrees. If I go any further, it would be a little bit too much.



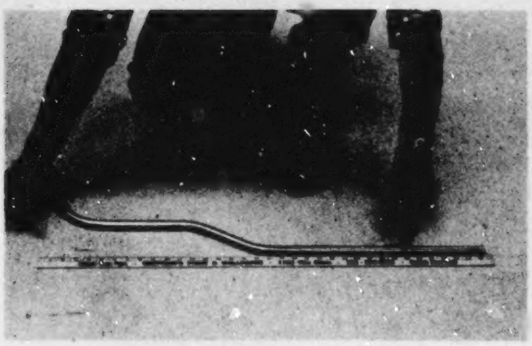
Now, I've got to come back up with the pipe. You notice that if we lay this on the board, the pipe goes down. Right? But I've got to come back up, don't I to get through that wall, so I want to bend up at the second mark I made. Now this time remember, you've got to bring this piece of the pipe up. To do this I'm going to again line up my mark with the arrow; but this time notice that the first bend on the pipe is pointing down. Remember to keep the first bend pointing straight down to the ground.



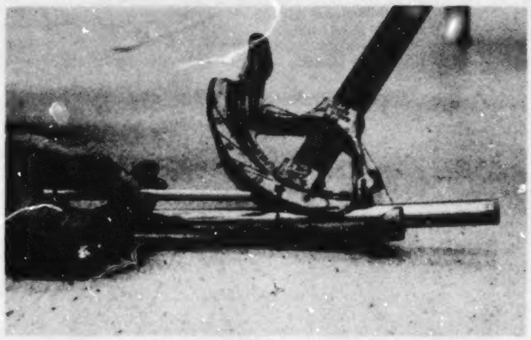
This bend is a little bit harder to do, because you don't have quite as much of the tubing to hold onto, but you still do it the same way. Get it up underneath your arm pit and just go down with your weight until it gets to the thirty degree mark. OK, we bend it down. . . stop. . . take a look at it. . . we need to go just a little bit more. . . OK, that's it.

Now, let's put that on our board and see how we're doing. Well, there it is. It goes down from the stub bend, across this floor support, through this wall. Now it's your turn to add this bend to your pipe. Remember to make the ten inch mark then measure six more inches for your second mark. Now try and see if you can do this bend.

If everyone's had a chance to practice let's go back to the tubing that I was bending. I've got a problem. My last bend must come up this other wall to reach the light switch. Right? You'll notice on your board that it's marked twenty nine inches from the back of the first stub bend to our last bend, so we need to do a twenty nine inch back-to-back bend. Look at the pipe; this last bend must come up this direction to the switch.

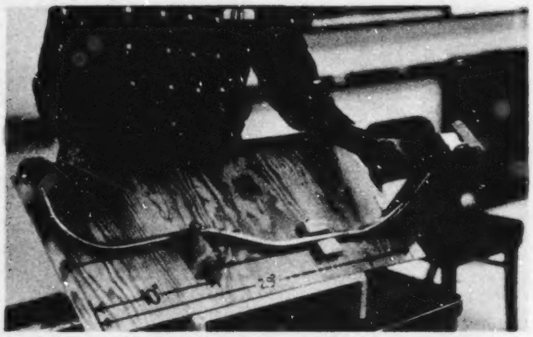


OK, let's take the pipe off of the board, and use the tile here on your floor to help line up our tubing. We'll put the edge of the first bend on one of the cracks of the tile, then lay our yardstick down against the edge of that crack, so that the back of the first bend is lined up with the edge of the yardstick. We measure twenty-nine inches, make our mark, and, again, we mark all the way around the tubing.



OK, now, we're going to use the starpoint on the bender that I showed you at the beginning of the lesson. Remember? This time when we put the tubing into the bender, we line it up to the starpoint.

Here's something you've got to think about: which way do you want your bend to come up? Lay your pipe on the floor and think about it. To reach that light switch, that pipe has to come up this way - right? So we have to bend it that way. With one foot, we hold the pipe down, and with the other one, making sure that our starpoint is lined up with the mark, we step on the bender and pull with our hands. Step and pull; step and pull, til it comes straight up in the air. OK, let's look at it. That looks about right.



So let's find out how it looks on the board. We'll take the bender off, then put the pipe on our example board. Look there, it fits just fine.
Now that we've shown you how to do the three bends, why don't you practice this last twenty-nine inch back-to-back bend. After you finish practicing, you may get your tubing and make as many of these bends as you can. But everyone will all start together, so keep practicing until we tell you.